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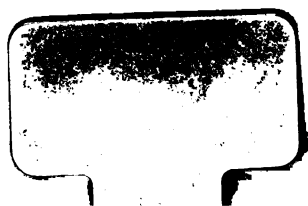
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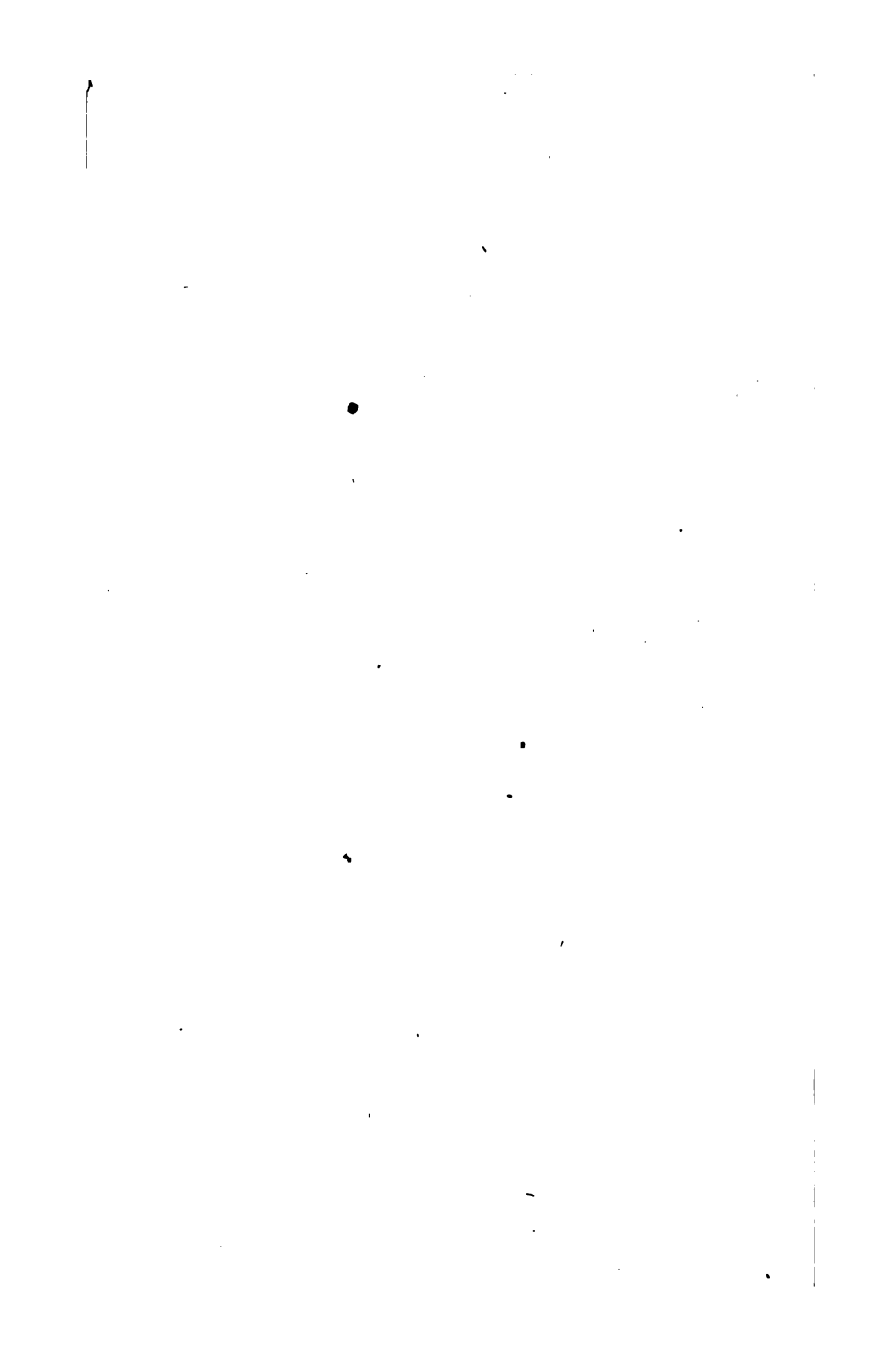
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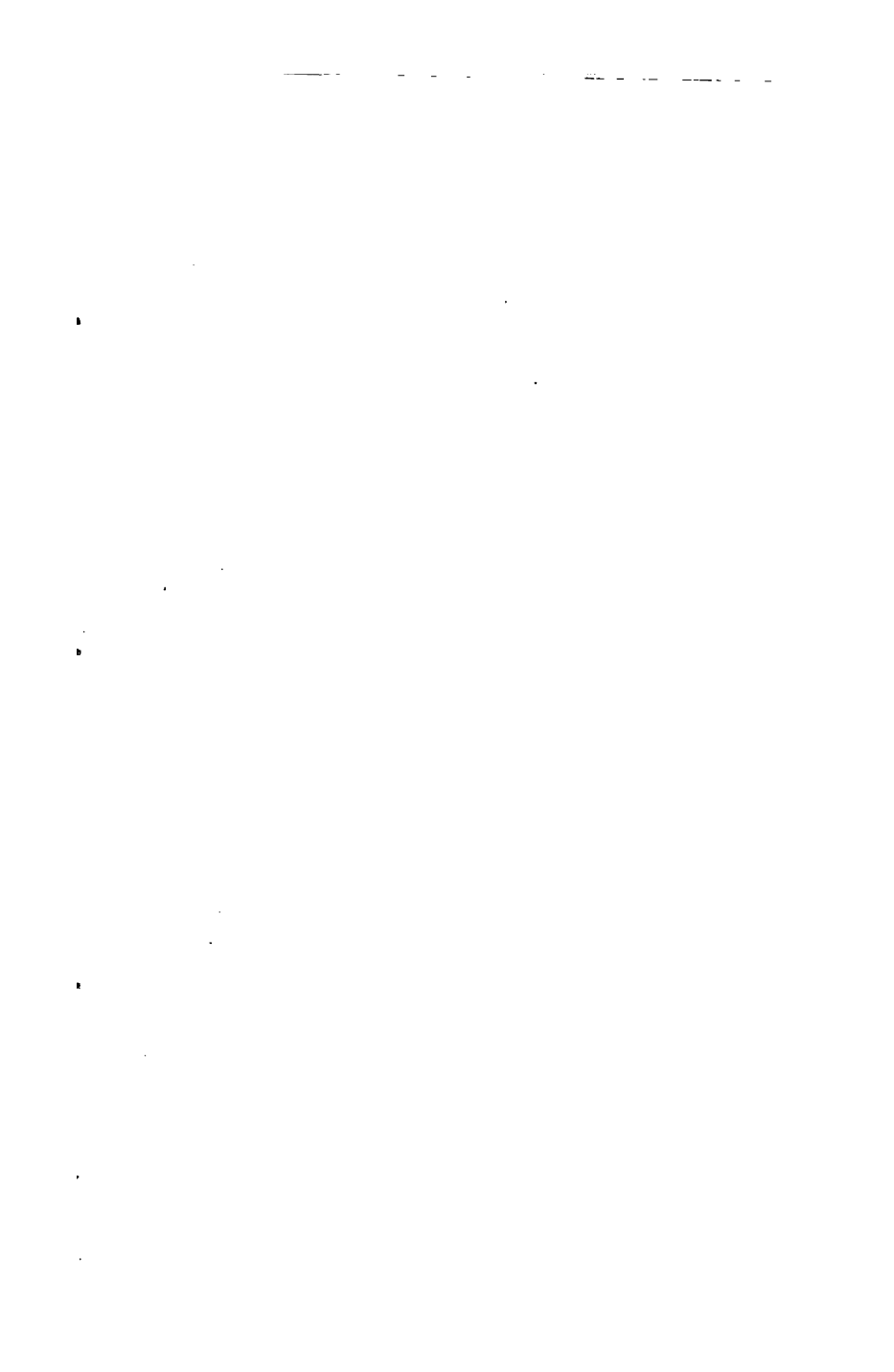






OLD STONES,

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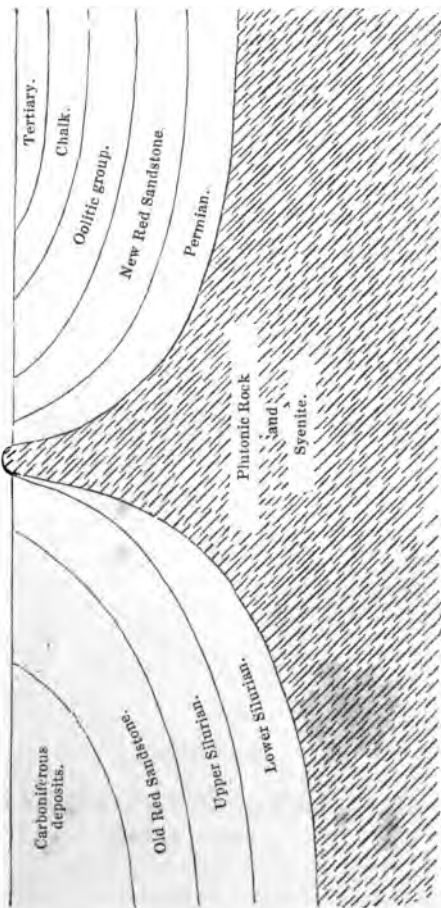
Section showing the succession of Strata
west of the Malvern range.

W.

Syenite.

Section showing the succession of Strata
east of the Malvern range.

E.



OLD STONES:

Notes of Lectures

ON

**THE PLUTONIC, SILURIAN, AND DEVONIAN ROCKS
IN THE NEIGHBOURHOOD OF MALVERN.**

By W. S. SYMONDS, F.G.S.

RECTOR OF FENDOCK.



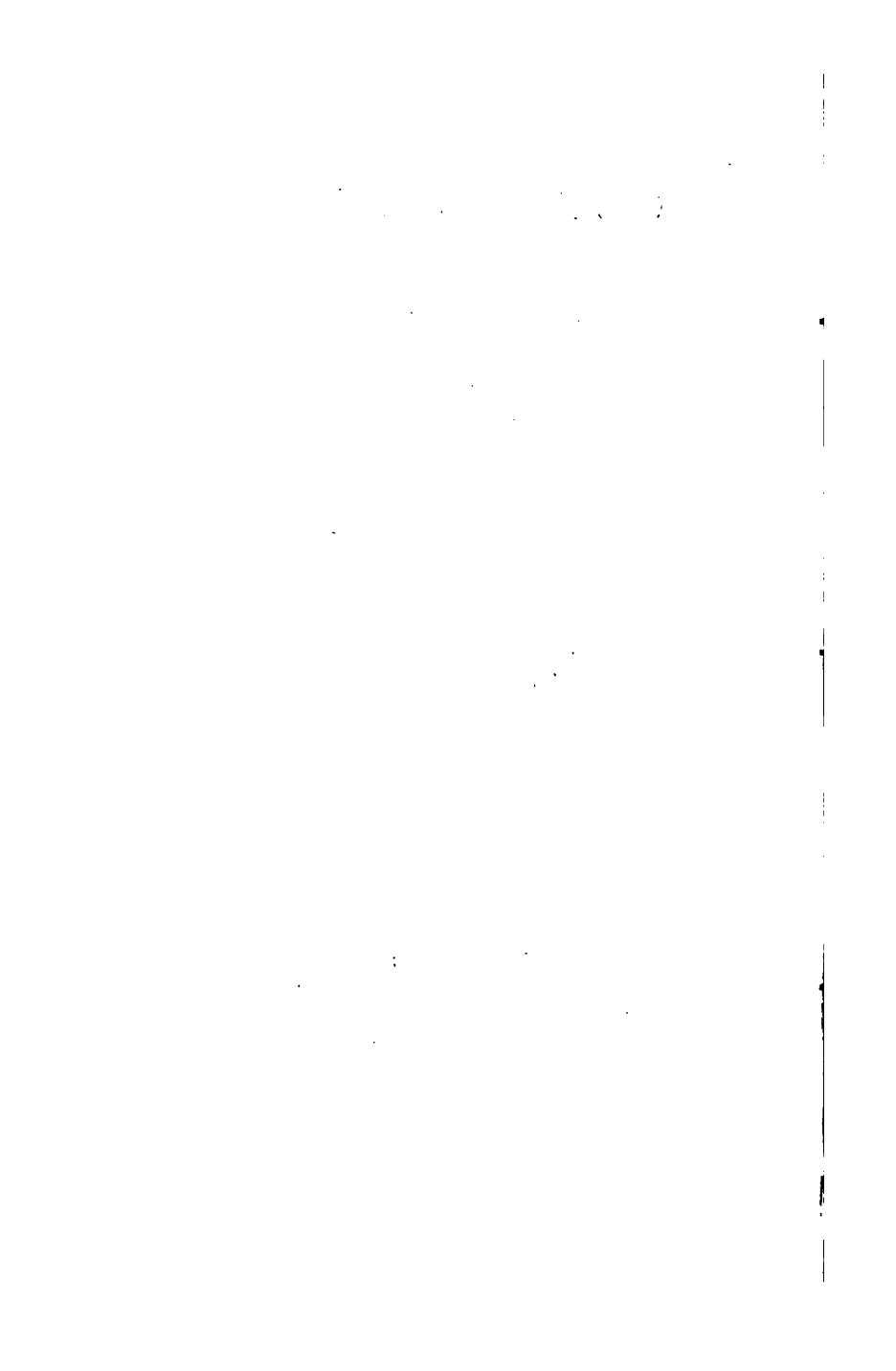
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1855.

188. c. 35.



TO
THE MEMBERS
OF THE
MALVERN, WOOLHOPE, AND COTTESWOLDE
Natural History Field Clubs.

To you, my Friends and brother Naturalists, with whom I have passed so many happy days, and from whom I have received much kindness, hospitality, and courtesy, I beg to dedicate this little work.

*Pendock Rectory,
April 18th, 1855.*

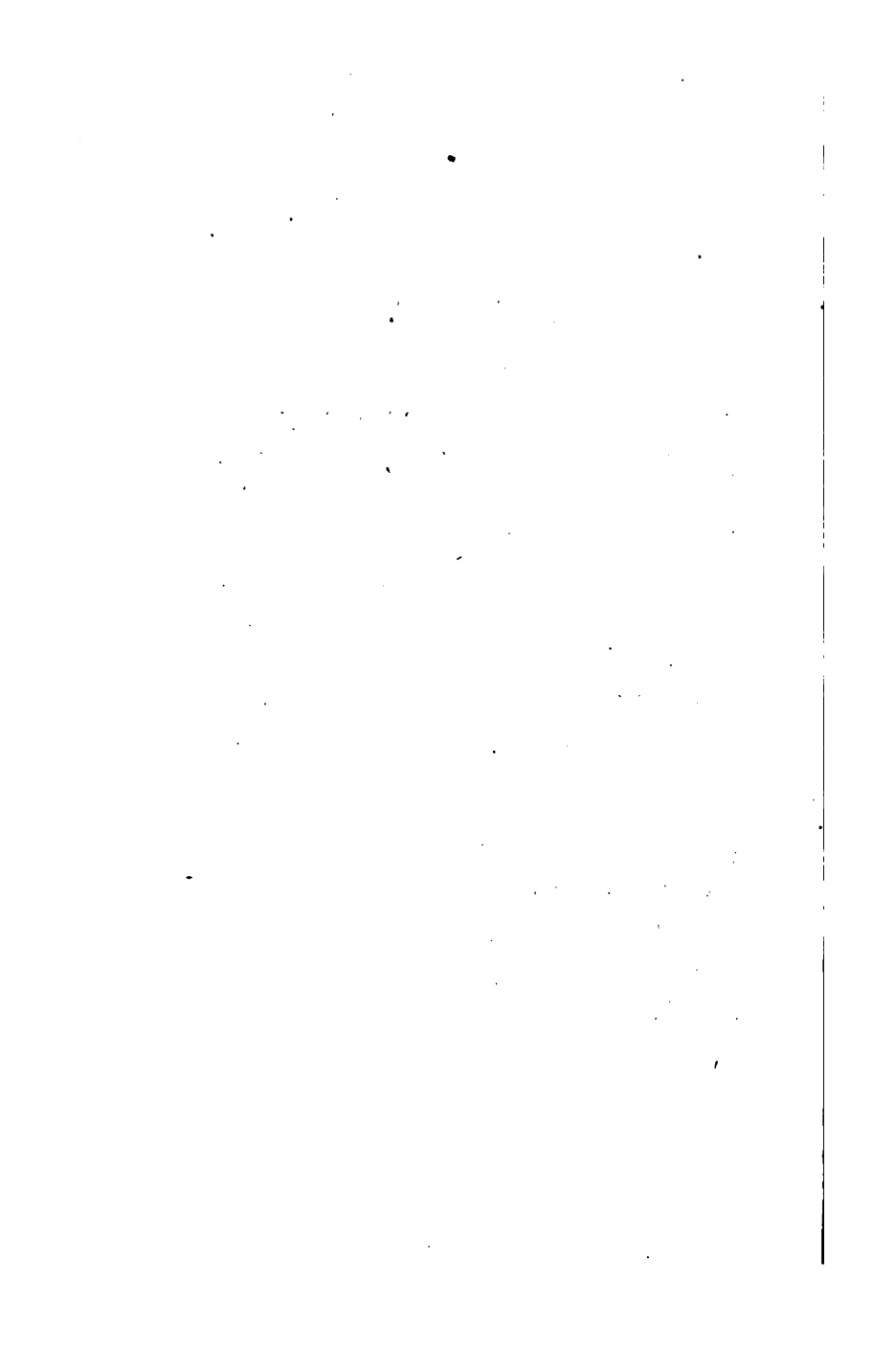
WILLIAM S. SYMONDS.



PREFACE.

A PORTION of "Old Stones" has already appeared before the public, in the shape of Lectures delivered by the author at different places in the neighbourhood of Malvern.

Kind and sanguine friends have requested the publication of these Lectures; and in the hope that this little volume may be of service to young geologists, and perhaps serve as a stepping-stone to the works of the Masters of the science, the author commits it to the printer's hands. He feels certain that the public will be disposed to look more favourably upon the "little book," when they are told that "Old Stones" are published in the hope that they may assist in restoring the old tower of an Old Church.



OLD STONES.

CHAPTER I.

Opinions of astronomers on the former state of the planet's surface—Increase of heat as we descend—Volcanoes now active—Earthquakes connected with volcanoes—Evidence afforded by chemistry and mineralogy—Principal minerals of the Malvern syenite—Experiments of Mr. Gregory Watt—The planet once in a molten state—Formation of the first stratified deposits—Thickness of the sedimentary deposits—Calculation of periods necessary for their accumulation—Earliest condition of the planet, affected by internal heat—First life—A lingula the first shell—First graptolite and trilobite—Palæozoic, a significant term—Lower silurians of Malvern—Malvern Chase—Altered sedimentary deposits, Holly-bush sandstone and black shales of the valley of the White-leaved Oak—*Agnostus pisiformis* and *Olenus* of the black shales—Trap bosses—The last lecture of Mr. Hugh Strickland—Minerals of the syenite necessary to vegetable and animal existences.

“WHAT may those hills be, sir?” said a gentleman one day, as the train was running rapidly along between Worcester and Cheltenham. I

replied, without reflection, "Oh, they are Plutonic rocks." My fellow-traveller looked up with an inquiring stare, and his countenance expressed a half-doubt whether or not I was in my sober senses. Thus recalled, I informed the stranger that the picturesque ridge we were rushing past was the well-known chain of Malvern Hills. One question led to another, and I tried to explain that the term "Plutonic" was applied by geologists to a mass of rocks that had formerly been melted like the lava of volcanoes, and had afterwards been slowly cooled and crystallised at enormous depths in the bosom of the planet; that it was derived from Pluto, the ancient god of hell; and that geologists applied the term "Plutonic" to ancient volcanic masses cooled and crystallised, in contradistinction to the erupted matter of recent volcanoes, such as lava. If I may judge from the half-sarcastic, half-pitying nod my travelling companion vouchsafed at the station when I wished him good morning, I fear my second explanation only confirmed his first impression of my mental sanity.

Thousands of visitors frequent the far-famed hills of Malvern; how few know that the very

ridge upon which they stand was once a molten mass, deep down below ; that the Herefordshire hills upon the west are upturned beds of sedimentary and hardened deposits, that once covered up this ancient, cooled, and consolidated lava of the Malvern ridge ; and that earthquake action and volcanic agency elevated, from a depth of many thousand feet in the earth's interior, the " Plutonic rock," the once molten mass—the Malvern range ! The history of the changes and complicated disturbances which have occurred in the Malvern district, and which are connected with subterranean forces on the most extensive scale, must be compared with changes now in progress in our own times, before we can understand the first letters of an alphabet that constitutes the language of our " Old Stones."

Without discussing the vexed question respecting the nebular theory of the universe, and whether our earth and the rest of the planets are zones of nebulosity thrown off successively from the sun, we may state, that the researches of all astronomers of *any repute* have led them to form the opinion expressed by the author of the Essay on the Plurality of Worlds, " that the solid materials of our globe were formerly

fluid, possibly that they were formerly gaseous and nebular ;” and certainly the light shed by modern geology upon the dark and mysterious pages of the earth’s history goes far to corroborate the profound investigations of the astronomer. In the first place, it is generally admitted by philosophers who have spent much time in investigating the question, that the central portion of the planet we inhabit is *now* occupied by a molten fiery mass of mineral and metal. The lava torrents of upwards of 300 *active* volcanoes that from time to time pour forth their fiery contents at different parts of the earth’s surface ; the numerous hot springs that rise to the surface in almost every country ; the startling shock of earthquakes in volcanic regions, with occasionally a throb in our own, for instance, the earthquake of 1853 ; and the sciences of the chemist and the mineralogist,—all afford irresistible evidence of the igneous condition of the interior of this planet. Indeed, the mean rate of increase of heat, as we descend towards the fiery depths below the crust, has been stated by the British Association to be one degree of Fahrenheit for every 45 feet ; and it is a well-known fact, that in deep mines the workmen are ob-

liged to wear the lightest clothing on account of this internal heat. Thus, accurate calculations have been made that the external crust of the planet cannot be more than from 60 to 100 miles in thickness ; and Mr. Michell supposes that " water may at a certain depth become incandescent without expanding ; and that even air, if it could ever penetrate to such depths, may become a liquid."

Now, we know that this earth is 8000 miles in diameter, and therefore that it must be 4000 miles from the point below our feet to the centre : thus, if we allow 100 miles of solid crust, we have left 7800 miles of molten mineral masses to traverse before we reach our antipodes, the hardened surface on the opposite side of the planet.

Before we speak of the ancient *volcanic*, or rather Plutonic, rocks of the Malvern range, allow me for a few moments to call your attention to a few facts connected with those volcanoes that are *at present active* ; the masses of molten mineral, called lava, that they discharge ; and the effect caused upon the surface of the earth when that discharge is in any way obstructed. The history of Mount Etna alone

might furnish a volume upon this subject. It is nearly 11,000 feet in height, and pours forth from its crater streams of lava, some fifteen, some twenty, and some thirty miles in length. In one eruption, A.D. 1669, the burning torrent inundated a space of fourteen miles in length and four in breadth, burying beneath it 500 villas and other habitations. In Iceland, A.D. 1783, Skaptar Jokul poured forth lava for *six years* without ceasing; and we are told by those who measured the depth, width, and length of its lava currents, that "two streams were poured forth, one sixty miles long and twelve broad, and the other forty miles long and seven broad, and both with an average depth of 100 feet." (Hooker's *Tour in Iceland*.)

Even this slight allusion to the effect of volcanic action in throwing up molten matter might alone lead us to understand that there is an enormous mass of liquid and fiery material within the interior of the earth; and that this igneous mass continually generates gases, vapours, and other explosive materials, by which, if there were no vent or outlet, the surface would be blown to atoms. We may form some idea of the enormous force exercised by the heated

vapours and gases below, from the fact that the column of lava raised above the sea-level during an eruption amounts to upwards of 11,000 feet, or more than two miles, in Etna, and in Chimborazo to upwards of 22,000 feet, or four miles, before it begins to overflow. Well, then, may the 300 volcanoes which the great Creator has spread abroad over this planet be called 300 "safety-valves."

Occasionally the explosive materials within do *not* find a vent at a particular point; and the consequence is that upheaving and shaking, and sometimes rending of the earth's crust, which constitutes the earthquake.

The regions which are most convulsed by earthquakes are those which include within them the site of the active volcanoes; and earthquakes, sometimes extending over vast areas, precede volcanic eruptions.

To us, who are far removed, happily, from the neighbourhood of the "safety-valves," it is difficult to comprehend the words of Mr. Darwin, on beholding the effect of earthquakes, and the gradual uprising and sinking of land in South America, for miles and miles together, when he says, "Daily it is forced home on the mind of

the geologist, that nothing, not even the wind that blows, is so unstable as the level of the crust of this earth." But so it is; and even within the historical period we have abundant instances on record,—witness the late catastrophe at Broussa, the great earthquake of Lisbon, the immense tract submerged at the mouth of the Indus, the elevation of the coast of Chili, and the destruction of towns and harbours in the West Indies, the destruction of Talcauano and Concepcion on the coast of the Pacific, as witnessed by Mr. Darwin himself so lately as 1835; witness the elevation of land from the bed of the Pacific, containing the relics of the present inhabitants of the sea, for hundreds of square miles together. We have but to make ourselves acquainted with the history of facts accumulated by many whose evidence is indubitable, in order to feel convinced that forces rest beneath, which, if called forth, might rend a world; but which are yet so beautifully and so perfectly under *His* control, that slowly and imperceptibly whole continents are uplifted and depressed. The shores of the Baltic are gradually rising; and in a future geological age the very spot where our gallant fleets were anchored

will in all probability become the home of *land* animals and land vegetation; while the celebrated coral reefs of the Indian and Pacific oceans are the reminiscences of a departed world, "where mountain after mountain, and island after island, have slowly sunk beneath the water" (Darwin). It is impossible here to enter into any thing like necessary detail, when whole volumes, penned by such true philosophers as Sir C. Lyell, Dr. Daubeney, and Mr. Darwin, have not exhausted the subject. Suffice it for our present purpose to allow that volcanic agency is one of those principal causes to which may be ascribed the great changes that have taken, and still are taking place upon our globe, as regards the elevation and depression of land. If I were to say to those who are unacquainted with geological facts, I can take you,* within a short half-hour's walk of your own doors, to former scenes of earthquake upheaval and volcanic power,—I can point out to you the indisputable proof of the convulsion, and uplifting, and overturning of the earth's crust for miles and miles together,—you shall stand upon

* Much of this chapter was delivered by the author in an address upon the "Geology of the Malverns."

beds of hardened lava, that were generated myriads of ages ago in the dark recesses of the planet's bosom. If I were to tell you that the ancient lava (Plutonic rock) gradually cooled, and became the solid rock you now see, and that above it were deposited vast masses of sedimentary and stratified deposits, themselves the representatives of past ages,—that ocean-beds above ocean-beds arose, until the time came when the power of old earthquake and volcano was called forth, and from the depths below our lava of other times was lifted solidly through the superincumbent masses,—and that this once molten mass is now the great bulk of what forms your “Malvern Stones,” the Plutonic range of Malvern rocks;—if, I repeat, I say this, some of you may feel inclined to look as much askance as my friend of the railroad. Yet it is true that every fragment of stone from the summit of your beautiful hills is a portion of what was once a *molten mass* of mineral, deep down in the fiery recesses of the earth.

I mentioned that the sciences of the chemist and mineralogist afford evidence to the igneous condition of the interior of the planet; we will

for a short time call in their assistance in investigating our history. No one can have explored the Malvern hills, especially that one towards the end of the southern range, called "Midsummer Hill," without noticing a considerable quantity of a white crystalline stone, commonly known by the name of "quartz." If you picked up a pebble of this kind in Scotland, and asked a peasant what it was, in all probability the answer would be, "Dinna ye ken, mon, it is just a stane?" Display it in Malvern, and the chances are you would be set down as a purchaser of the "Spar—gold mine—silver mine, please sir!" that Malvern visitors are occasionally persecuted with.

The mineralogist, however, has brought an amount of knowledge to bear upon common stones, such as our quartz pebble, which, assisted by the aid of chemical analysis, has made the subject of great importance in the question before us.

We learn that the mineral "quartz" has, by a long and difficult process, been reduced to its base, "silicon," a true elementary substance, as elementary as is the oxygen and nitrogen that we breathe; we learn that by the

union of silicon with oxygen, silica or *quartz* has been produced, a substance most abundant in nature, and most important to the vegetable world; and we learn, moreover, from the same sciences, that this same quartz or silica is as certainly the product of volcanic action as is the lava-torrent of Etna or Vesuvius. The hot springs of Iceland and the Azores have their waters charged with silica in solution; this silica being obtained from the depths from which they arise, just as the waters on the surface dissolve and take up particles of lime from the limestone rock through which they flow. As oxygen and hydrogen form water, so do oxygen and silicon form quartz. Another mineral, called felspar, is of considerable importance, the crystals of which assume that beautiful flesh red so common in the "Malvern stones." Now this mineral is a chemical combination of our first stone, quartz or silica, with alumina, or clay, and also of silica and potash. I am not now treating upon mineralogy; but I particularly request your attention to the fact, as bearing upon our question of the former igneous condition of this globe, viz. that the bases of these substances all tell, more or less, of their *volcanic character*. Potassium,

the base of potash, thrown upon water, instantly takes fire. Aluminium, the base of alumina, does the same, when slightly heated. Sodium, the base of soda, though not so inflammable as potassium, will inflame on the application of water. Hornblende and mica are the principal minerals that constitute, with felspar and quartz, the ancient volcanic mass, the Malvern *syenite*; and I shall not allude to them further than to say, that the hornblende is that dark-greenish coloured mineral every where so common among these rocks, and the mica is the "gold and silver mine" of the Malvern urchins. Both are volcanic products, and together enter largely into ancient volcanic rocks.

The Malvern range consists, then, of a compound of these minerals, all having an undoubted igneous origin; and this compound, geologists call "*syenite*," from a town (Syene) in Egypt, where a very similar rock is found.

Many terms are applied to other varieties of Plutonic rocks, such as trap, greenstone, and basalt, the nature of which it is not within our present scope to entertain. I need only say, that basalt differs very little from modern lavas; and Dr. M'Culloch observes, that "from lava

to trap, or basalt, and from thence to syenite, porphyry, and granite, there is an uninterrupted succession: as agents in geological changes, trap and granite are identical." (*System of Geology*, ii. p. 100.) The experiments of Mr. Gregory Watt prove the correctness of this inference. The basaltic columns of Staffa and Iona are well known, as also those of the celebrated Giants' Causeway; but the columnar structure in the basalt was a puzzle until that celebrated chemist proved it to have originated from the manner in which it *cooled down*,—a very important consideration, when we remember the vast quantity of lava that is poured into and under the sea. Mr. Watt melted 700 weight of basalt, and kept it in the furnace several days after the fire was reduced. It fused into a dark-coloured vitreous mass with less heat than was necessary to melt pig iron; and when it cooled down again into a stony mass, it was converted into *polygonal prisms*.

We are often not aware how much we lose from our want of observation of home facts and circumstances. Frequently, because scenes are familiar they lose their charm, and the magnificence of surrounding scenery is too often not

appreciated if *near home*; yet what means do we all possess of varied enjoyment and instruction within reach of our own doors! These fine old Malverns, the components of which are coeval, for aught we know, with creation itself, call upon those *rational* beings that live around their base to investigate their most startling history; yet how often are they passed by altogether unobserved! They can tell of associations connected with a period when "life was first breathed upon the waters;" but they are familiar, and they escape attention. Amongst the thousands of visitors who seek their bracing air and pure waters, I do not suppose half-a-dozen care to know their history; and of the hundreds who live beneath their shade, perhaps another half-dozen alone think it worth their while to inquire into the former conditions and associations of their "Old Stones."

It seems, then, most probable that, in that far and distant period into which no human eye may gaze, when "the earth was without form and void," the planet existed in an entirely fluid state, and as a globe of molten matter; and as it cooled, a crust formed on the surface, which would at first be composed of such particles as

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our Malvern syenite; these particles to a degree tell their own history.

After water was created, and had existed for a certain period, these first rocks would be acted upon by the waters, would be gradually ground down and spread in the hollows of the planet's crust; doubtless, it was thus the *stratified deposits* were commenced, though the first cooled surface was entirely composed of once molten Plutonic rocks. To those who are acquainted with the elements of geology, stratified deposits, aqueous rocks, and strata, are very simple terms, and convey a meaning at once understood; there may be some, however, to whom such terms are as a "closed book," and to such I may be allowed a few words of explanation.

It is almost impossible to travel through any country without remarking large masses of rock, which lie layer over layer, and bed over bed with the utmost regularity and order. If we take the trouble to examine them, we find also that these rocks are entirely made up of water-worn materials deposited in the bottom of some sea, or lake, or river; but more than this, if we begin to take a higher interest in the research, and examine still more attentively, we shall find

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*Condition of the Malvern District before the upheaval of the stratified deposits
by the Plutonic forces.*

Surface previous to the Permian epoch.

Carboniferous deposits.

Old Red Sandstone.

Upper Silurian.

Lower Silurian.

Syenite.

Present surface of the Malvern Hills.

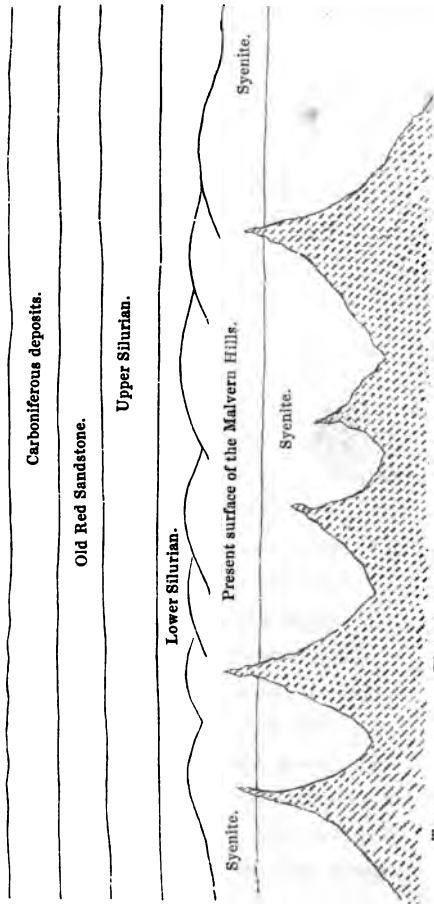
Syenite.

Syenite.

Trap.

Plutonic Rock.

Trap.



that, far away inland, on the tops of the highest mountains, nay, even on the Himalayas, 22,000 feet above the level of the sea, many of these masses of rocks contain thousands of delicate shells and other fossils, such as fish of strange and unknown forms; and that these *stratified rocks*,—so called because they are accumulated bed above bed, layer above layer, stratum above stratum,—range over whole countries and immense areas. It was the fashion in days gone by, to talk, and sometimes to write, of the eternity of this planet; but geology points to the evidence of a beginning; whether that beginning refers to the first formation of a crust upon the surface of the planet, the first evidence of a stratified deposit, or that first period when “life was breathed upon the waters.” The evidence may be hard to sift, and the path difficult to tread, before we arrive at these conclusions; but when all things are calmly weighed, and each test carefully and diligently worked out, I cannot avoid expressing my belief, that geology impresses the mind, perhaps more than any other subject of natural history, with the truth of a beginning, and the far-reaching and *eternal* agency of the First Great Cause.

Now, it is on *ancient volcanic rocks*, upon a cooled-down crust of once-heated matter, that the lowest stratified deposits rest ; and these are the first evidences we possess of the action of water upon the trap rocks themselves ; and each stratum as certainly represents a certain period of the earth's surface in former days, as the external surface—mould, sand, and rocks—represents the present period. It has been carefully calculated, that if we added together the entire thickness of the several formations that make up the aqueous sedimentary deposits, or strata, that have been piled one above another, since the first water acted upon the hardened igneous crust, and spread abroad the first thin stratum of a sedimentary deposit, we should find it would amount to a total of 94,000 feet, or more than 17 miles. (Jukes, *Popular Geology*, 329.) I cannot now enter into the arguments which geologists bring forward to explain the enormous amount of time that must necessarily have passed away in order to allow this thickness of strata to be deposited ; I will merely mention two careful calculations made by two careful men, Manfredi and Sir C. Lyell. Manfredi, the celebrated hydrographer, believed that it

would require a thousand years for the sediment carried down to raise the general level of the sea a single foot. Sir C. Lyell has worked out the second somewhat in the following manner :—

The length of time necessary for the accumulation of a sedimentary deposit may be determined by simply counting the dead remains of some very humble, but very faithful witnesses. Few fishermen, and no naturalists, are unacquainted with the singular houses manufactured by the larva of the May-fly, commonly called the caddis-worm ; there is hardly a brook in England that does not contain these curious mansions, with their ornamental envelopes of little fresh-water shells or pebbles. They mark, too, especially, the *annual* deposition of sedimentary matter. The May-fly soars at the commencement of summer, and lives its transient life in the sunshine of a day ; but it leaves behind the empty sheath to be covered by the mud and silt which flow down with the autumn and winter floods. Another spring-time, and we find the surface occupied by other caddis-worms ; thus do these tiny insects constitute a chronological table, telling an annual history of the past,

Now, mark the sequel to this tale. There is a fresh-water limestone in Auvergne in France, very insignificant indeed, when compared with the great geological series, as regards the history of past time, and yet how significant with respect to a practical mode of calculation ! This limestone is of the early Tertiary, one of the last geological periods, and only a very slight representative of that, and it is entirely made up of the cases of ancient fossil caddis-worms, each separated by a thin film of earthy sediment ; yet does this sedimentary deposit amount to the thickness of many hundred feet. The layers of the annual moultings of the fossil caddis-worm have been counted and reckoned ; and thousands and tens of thousands of years have rolled away since the period when that caddis limestone was first deposited, until the time arrived when it should close.

In geology, we learn these lessons over and over again ; and no elementary lecture of this kind can give any idea of the evidence that on all sides surrounds us, of the vast, the unmeasured lapse of time since first our planet was called into being. Requesting you, then, to bear these examples in mind, I will run up the

GEOLOGICAL LADDER.

	Recent.	
	Pleis:ocene.	} Tertiary.
	Pliocene.	
	Miocene.	
	Eocene.	
	Chalk.	} Secondary.
	Green Sand.	
	Wealden.	
	Portland Oolite.	
	Oxford Clay.	
	Oolite.	
	Lias.	
	New Red Sandstone.	
	Permian.	} Palæozoic.
	Coal.	
	Millstone Grit.	
	Carboniferous Limestone.	
	Old Red Sandstone.	
	Upper Silurian.	
	Lower Silurian.	
	Cambrian & Metamorphic.	} Primary.
	Granite, Syenite, &c. &c.	

ladder of stratified deposits, and then again refer to our "Old Stones."

You will observe that the whole ladder of stratified deposits rests on what once was a molten mass, now cooled down into hard crystalline Plutonic rock. Now, each of those stratified deposits was in its turn as certainly the outer surface of the earth's crust as is now the ground upon which we tread. The lower rounds of the ladder—the lower strata—are themselves roasted, baked, and altered by intense heat, by having heated masses poured through them in every direction. But the Plutonic masses in the earth's interior have had another effect; besides *baking* sedimentary deposits, they have blown the strata up from the horizontal position in which they once lay. Each stratum once lay "like a book in a chest, with other books packed above it." Through the uplifting agency of earthquakes of many remote ages, we have the edges of entire formations turned up to the surface, and they lie now, thanks to *trap* and syenite, like books upon a shelf; we can read their contents too, and measure their thickness, and some very singular histories there are written in their

pages. In travelling from our West Coast to the East, or from Bangor to Yarmouth, you would pass over all the strata indicated by different colours on the map, and you would find that you ascended from lower to higher beds as you travelled onwards; for instance, Lower Silurian pass under Upper Silurian strata, these are again covered up by the Old Red sandstone, the Old Red sandstone by the Carboniferous deposits, and so on, until you reach the uppermost beds of all—the upper Tertiary and Pleistocene. As I said before, these strata, once deposited one above another like books in a box, are now arranged edgeways like books in a library; and the knowledge contained in them may also be represented in a similar manner. Each of the coloured volumes, or formations, contains its leaves, its distinct layers of stratification; and on those leaves is a printing of the Deity,—a history so marvellous, that none but those who have read and studied its contents can form the slightest conception of its wonders and its truths. It is that history, as regards the fossils of this district, which we have now to treat on.

At the very earliest period in the by-gone

history of the planet, in that far beginning in which water first existed on the globe, and solid rocks appeared above and below, for that water to wash with its waves and wear away with its currents, the *result* of that wearing-down erosive action, the sand, mud, or silt, *detritus*, as it is called, must have been spread out in strata under the water; and ever since the formation of that first stratified deposit, age after age, century after century, for myriads of years, has that accumulation been going on down to the present time. "The earliest condition of the earth is necessarily the darkest period of its geological history;" and the most eminent geologists believe that there was a long period when the internal heat of the earth so affected the first surfaces that it was impossible that living beings, as at present constituted, could exist. At all events, at the very base of the long ladder of sedimentary deposits there is an enormous thickness of stratified rocks, upwards of 20,000 feet, which have not afforded the slightest trace of a living animal. I should, however, mention that beds supposed to correspond with the uppermost of these strata, in Ireland, have furnished one instance of a living

creature throughout the long period which must have elapsed during which these lower rocks were being deposited: and that fossil is very low in the scale of animal life, only a Coral! Sir R. Murchison says, the geologist may "look with reverence on that ancient zoophyte;" for, notwithstanding the most assiduous researches, it is the first animal relic we find at this early stage of the planet's surface.

Step by step, round by round, as we mount the geologic scale, and leave these first inhospitable rocks, called "Cambrian," the inquirer finds fresh proofs of the exertion of creative power. "Old actors go out, and new ones come in on the stage of organic existence; and each new formation is, as it were, the lifting of the curtain and the discovery of a new scene." Observe those lower beds of the group called Lower Silurian rocks; there, for the first time, does the molluscous animal (shell-fish) make its appearance. This is a very lowly mollusk, and is called a *Lingula*. It is very remarkable that the covering of this animal, which lived in immense numbers in those early seas, had rather a horny covering than a shell, and thus was better suited to a sea that contained little

or no carbonate of lime, wherewith it might make a thicker shell.

Lingulas exist in the present day; and they possess a kind of cartilaginous or fleshy foot-stalk, wherewith the animal attaches itself to the rocks, and thus looks just like a little garden shovel. Those of the present seas, however, are of different species to the first tenants of the primeval ocean. Associated with these first shell-fish, are a few little animals allied to the lobster and crab tribe, though very different; and we shall allude to them more particularly just now: they are called *trilobites*. There are a great many species of these strange creatures in the lower strata; but they disappear from the surface of the earth for ever after the Carboniferous period. These beds contain another queer creature, which has ages ago ceased to exist; it is called a *graptolite*, and was in a measure allied to the sea-pen, a zoophyte which inhabits muddy bottoms in our present seas.

We will just compare the animal kingdom, as it at present exists, with the evidence we possess of the animal kingdom as it existed in this *first period*,—*this beginning of animal life*. Now the earth contains a large class of verte-

brated animals,—animals with a bony internal skeleton,—such as men, beasts, birds, reptiles, fish: what evidence have we of the vertebrated animal among these first animals? Not a shadow! Now we have a large class called the molluscous, containing many orders, genera, and species; cuttle-fish, shell-fish of all sorts and description, such as snails, oysters: what do we find at the earliest period of life of all this immense class? One little lingula! Then come the annulose animals, the great insect tribe: of all the spiders, flies, beetles, and a thousand others of this class, not one is known in these lowest fossiliferous rocks! The crustaceans, such as the lobster and crab order; how many of these do we find in our ancient seas? Two species of minute trilobites! Again, we have the great radiated class,—star-fish, sea-urchins, corals, animalcules, sponges,—a collection of strange creatures spread abroad over every sea in immense numbers: what evidence of this great class have we in those seas of old? Two very lowly species of coral! Geologists give to the group of strata from the lowest fossiliferous beds to the secondary group a very long hard name, —*Palæozoic*; but it is a *very significant* one, for

it means that the forms of life found in those rocks are very ancient forms; and well might they say so. No form of graptolite (an animal allied to the sea-pen) is found above the Silurian group; no orthoceratite (a kind of cuttle-fish of this epoch) is found above the Carboniferous series; and the last of the many species of trilobites died out in the same Palæozoic era.

This term palæozoic refers to many a deposit, nay, many a thousand feet of sedimentary strata above these lowest fossiliferous beds, of which I have just spoken, and includes strata from the bottom of the Lower Silurian to the commencement of the New red sandstone.

But, step by step as we ascend, we find evidence of the creation of new beings, as the planet became adapted and fitted for their introduction. Thus, in the lowest beds of the Lower Silurian rocks we find only a few animals; as we ascend to higher beds of these same Lower Silurians, through thousands of feet, we find new shells appearing, new trilobites, new cuttle-fishes, and so on; indeed, upwards of 1000 species of animals are known in the Lower Silurian rocks alone, but not one belongs to the vertebrata—no *true backbone* appears amongst them; no fish,

no reptile, no bird, no beast. The "platform of life" wonderfully increases between the commencement of the Lower Silurian epoch and its close; but the platform is not yet high enough for vertebrated animals. The Americans thought they had fish in their Lower Silurian beds; they turned out to be gigantic crustaceans. I might give you a lecture, or half-a-dozen lectures, without exhausting the subject, though I might exhaust your patience, upon this home of first life—these Lower Silurian rocks.

LOWER SILURIANS OF MALVERN.

The old rocks that contain the first vestiges of life have, in Wales, as we said before, an enormous thickness; and one of the most striking circumstances of the geology of the Malverns is, that they possess such a vast *geologic range*; for we find Sir R. Murchison declaring that the "black Malvernian schists, however diminutive, may be as old as the lingula beds of North Wales;" and in which, for the *first* time, we find the *first* shell.

. In order to investigate thoroughly the Silurian succession of strata, and to form an idea of the great interest attached to the geology of the

Malvern chain, we ask our friends to accompany us for a while to the southern extremity, called the Key's-end Hill, above Bromesberrow and the Berrow,—it should be *Chase End*; for doubtless that was the original meaning, and indicated the termination of the great "*Malvern Chase*," where our forefathers hunted the wolf and the wild boar. The best plan for explorers from a distance would be to drive to the Duke of York, a village hostelry at the foot of the hills, on the Ledbury and Tewkesbury high-road; a short walk from hence, across the fields, will lead them to the Valley of the White-leaved Oak. A little stream wanders from among the rocks of this narrow gorge, and on the banks the earliest violet and primrose may be found. There is an aspect of peace about the cottages of that little valley, which make it a pleasant path; and the stones, if put rigidly to the question, reveal a strange tale. In ascending the valley, we have the *Chase-end* on our left, and the Ragged-stone Hill on our right. Just above the little bridge that crosses Mr. Ricardo's coach-drive, is a small farm-yard; and a little beyond, on the opposite side, the observer, "with careful eyes," may detect the thin beds

of "black shale" *roasted white*. The effects of the ancient lava, in altering the black shale, does not appear to have been more than local; for, ascending the valley for a few yards, we find these schists assuming their natural colour; and it was in the little cottage-garden on the right, just opposite the "coal bank" (so called from a heap of black shale on the left), that the late Mr. Strickland obtained the small trilobite, *Agnostus pisiformis*. You will have the goodness to remember the detection of this ancient crustacean, as it is a matter of considerable importance as a test of the age of these deposits, to which we shall again revert.

As we leave the black shales and still ascend, a small quarry on the right shows a bed of that peculiar greenish sandstone called by Professor Phillips Holly-Bush sandstone, and which, resting immediately against the Plutonic rock, is the bottom of the whole series. In this sandstone the only organic remains are impressions of marine plants. Above this point, until you reach the quarry at the head of the valley, the geology is obscure, from the beds of detritus which cover up the rocks. At the extensive quarries near the White-leaved Oak, we find

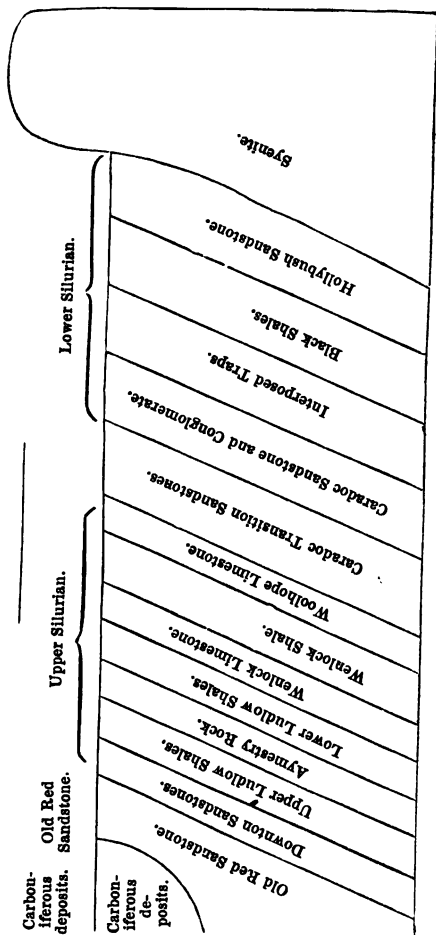
a compact Plutonic felspathic rock, well worth examining as a good example of ancient igneous rock. Professor Phillips, in his admirable work on the geology of the Malvern and Abberley Hills, makes the remark, that "in no part of the Malvern Hills are the trap rocks more varied in character than in the Ragged Stone; nowhere do they depart more widely from the syenitic type, and approach more nearly to the ordinary aspect of eruptive trap, abounding in compact felspar." A good deal of examination on every point of this remarkable hill induces me to believe that geologists are by no means yet acquainted with its history. The base of the hill, on the south of the West Ragged Stone, and on the north of the East Ragged Stone, shows the red syenite of the *North Hill*, and other parts of the Malverns; but the *upper parts* of these hills are composed, I believe, of a *trap* rock of a much later date than the *old* Malvern syenite. It is only at the *base* of the Ragged Stone that we find the representative of the true syenite of the North Hill; the trap of the Ragged Stone peak was certainly of *later* date than the formation of the black shales, for it has bleached them. The old syenite was elaborated and cooled long

before the formation even of these ancient deposits.

In the quarry at the crest of the ridge we may see a remarkable section of arched and twisted and altered sandstone, dipping to the westward under the beds of black shale, which on the opposite side of the ridge occupy the same position we observe on the eastern.

As we pass on from the ridge to the western side, we again recognise the green Holly-Bush sandstone, and unaltered. The black shales succeed to these; and, by carefully searching and splitting the laminæ, minute crustaceans (trilobites), called *Oleni*, may be detected. (The Malvern Field Club are indebted to Miss M. Lowe for some excellent specimens.) We mentioned the discovery of *Agnostus pisiformis*, another small trilobite, on the other side the hill, in the same deposit. It is to these fossils, as identifying the black shales of Malvern with very old Lower Silurians of North Wales, that we would especially direct attention. I have before stated, on the authority of the great Silurian geologist, Sir R. Murchison, that after the most assiduous researches, the lowest zone of animal life in Great Britain is the lingula schist of North

Section of Paleozoic Strata west of the Malvern.



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Wales, discovered by Mr. Edward Davis. It is, then, a remarkable and interesting fact for the Malvern geologist, that these lowest fossiliferous beds of Wales contain, besides the bivalve *lingula*, the little trilobite *Olenus humilis*; and, as if to assist in corroborating the fact that our Malvern black shales are identical with the lowest fossiliferous beds in Europe, the very last time Mr. Hugh Strickland ever visited the Malverns, he found at the spot I mentioned the "*Agnostus pisiformis*, a fossil only known in the oldest Silurian schists or alum-slates of Sweden." Indeed, wherever the above-mentioned fossils have been found, whether in England, America, Scandinavia, or Bohemia, they occur only in the "*lowest horizon of life*." For the geologist, then, the valley of the White-leaved Oak has charms that no other part of the hills possesses; for he may here explore strata charged with the earliest relics of life upon the planet's surface, and which he can only do elsewhere by a journey to the North-Welsh mountains. Here, also, the action of heat on the stratified deposits is plainly visible on the road from the White-leaved Oak to Fowlet's Farm. Trap bosses occur in the fields on the left of the pathway; and the in-

fluence of heat is distinctly traceable in the altered shales, while you may there behold the once-molten rock itself bursting forth at the surface. It is not to be supposed that one journey to this valley will suffice to comprehend these earliest relics of the ancient world ; I may say that years have passed since first I commenced the study of these " Old Stones," and every journey furnishes something new. The Ragged-Stone Hill and the little valley of the White-leaved Oak have for me, and I know also for others, another charm,—even that remembrance which still links us with those that are gone. The last lecture our lamented friend Mr. Hugh Strickland ever gave, was from the summit of this picturesque hill ; and I for one shall never forget the scene, as upwards of fifty of our country naturalists sat around, and listened to his description of past existences and bygone worlds. We never heard him again ; but it is some consolation to those who appreciated the goodness of his heart and the energy and humility of his mind, to know, that when the setting sun lights up the peaks of the " Ragged Stone," it shines full upon the obituary window erected by us to his memory

at the old church of Denhurst, in the distant vale, and that those last rays play upon words that tell volumes of his character,—“ To the memory of Hugh Edwin Strickland, a Christian philosopher; the tribute of *many friends*.” There is something, to those who are interested in physical geology, particularly striking in this part of the Malvern district. The evidence of volcanic action upon the sedimentary deposits, the peculiar contour of the hills, the great geological age of the strata and their animal remains, and the numerous trap bosses that occur from the valley of the White-leaved Oak to Fowlet’s Farm, all concur in presenting to us geologic records which we shall look for in this neighbourhood elsewhere in vain. In working out the volcanic history of Malvern Hills, the four bosses of trap, and their probable connexion with that in Cowleigh Park, require especial attention. And the observer will not fail to pay attention to the fact, of great importance in our history, that stratified deposits in contact with what we call the old syenite are never altered or changed by heat; while, on the contrary, metamorphism—a *regular roasting*—invariably accompanies the association of the trap of the Ragged-Stone Hill, the trap

of Fowlet's Farm, that below the Eastnor Obelisk, and that of Cowleigh Park.

Much more might be said upon the ancient volcanic rocks of Malvern, and the history of the earliest sedimentary deposits ; but time and your patience will not permit me to dwell longer upon the subject. At the commencement of this lecture I said a good deal upon the subject of the minerals that make up the syenite of the range. There is one part of the subject to which, if you will allow me, I would call your attention before we part, and that is, how very necessary these substances are where life itself is concerned. I do not know whether it has ever struck you, when looking upon the white quartz pebble of the Malvern hills, that you are examining a substance which enters largely into the food of vegetables, and which is absolutely necessary for the straw of our crops. Without silica in the soil we could have neither hay for our cattle nor straw to our corn. The pink mineral felspar also contains potash in great abundance ; and by the decay of the rocks and exposure to the weather, it is gradually brought into a soluble condition, and absorbed by the roots of the plants that flourish far and wide around the bases of

our hills. The hornblende contains a large portion of magnesia, the presence of which is necessary to constitute a fertile soil. This is a short and simple statement, which is worth reflecting on; for the sum of it just amounts to this, that without these minerals, these Malvern stones in nature, the vegetable world, and therefore the animal world, must *cease to exist*. Take away all silica, potash, and magnesia from the soil, and the earth would become a wilderness. For the last time, then, let me remind you that these minerals are the products of the ancient igneous rock, that lava, consolidated myriads of years ago in the depths of the planet's bosom, to become in after ages the means of life, growth, beauty. Surely, then, from the history even of these simple stones we may learn a lesson of the far-seeing power and future design of Him who fashioned both them and us. We gaze into the darkest recesses of the earth's history, but we behold nothing without its future purpose, to be developed for *after-good*, when myriads of years had rolled away. We bear about with us in our bodies and our blood elements which, though transformed, once existed in another form, it may be, at creation's dawn; and if

we learn no other lesson, we may at least learn this,—not to despise “common things,” such as stones, stars, birds, or flowers; but to remember when flowers blossom, stars shine, or birds sing, or even the pebble rolls beneath our feet, that God made them,—that there is a tale of wonder attached to each, if we but seek to learn it; and that man’s reasoning faculties cannot be better employed or more wisely directed than in the study and observation of His works, and in learning the truths they teach.

CHAPTER II.

Uppermost strata of the Lower Silurians—True Caradoc sandstone but slightly developed on the flanks of the Malverns—Middle group of the Lower Silurians wanting—Howler's Heath—Quarry of Holly-Bush sandstone—Prismatic trap on the Hereford and Ledbury high road—Trap bosses near Bronsil Castle—Caradoc fossils above Bronsil Castle and below the Obelisk of Eastnor, near the Gullet Pass—Mr. S. P. Woodward on the Brachiopoda—*Lingula* with a metallic tinge—*Pterygotus problematicus* found in these beds—Gullet Pass—Caradoc transition beds at the base of—Caradoc transition beds graduating into the Woolhope and Wenlock beds above—Found by Prof. Phillips on Swinyard Hill and the Beacon, also at Wind's Point—Gunwick Mill a good locality for fossils—The transition beds at May Hill—Different from the Woolhope beds—Woolhope limestone or Lower Wenlock deposits—Sunk into at railroad shaft—Large trilobites of, at Corton, near Presteign—Description of trilobites—Dr. Buckland on the organs of vision of—Curiosity—Vestiges of Creation—Trilobite's eye—Wenlock shale and limestone—Netherton Valley good for fossils—Orbicula of Colwall Copse—Corals—Denudation—Woolhope Valley, Stoke Edith, and Tarlington, a starting place—Dome of Haughwood—Corals of Dormington Wood.

WE mentioned that both astronomers and geologists allow an antiquity to this planet that

is startling to those unacquainted with the subject.

This *nervousness* proceeds entirely from *ignorance* of the facts with which we have to deal. An investigation of the great truths of the science sheds light upon subjects hitherto mysterious and dark.

The rocks of the mountain, and the stones of the field and quarry, form a pedestal upon which rests that science; the facts of which are perhaps more incontrovertible than those of astronomy itself. Those facts are *tangible*, and commend themselves to the senses; they are such as any one may study and investigate; and are now therefore never controverted, but by those who have not taken the trouble to examine the evidence.

CARADOC GROUP.

Leaving behind us the lowest Silurian deposits of the Malvern range, the succeeding steps of our geologic history reveal to our wondering eyes relics of the ancient seas, new to the observer as he mounts the scale of the planet's history, and which, like those shadows

of first life we have been considering, have for ages passed away from the scenes of earth.

To form the slightest idea of the enormous development of the Silurian strata, Shropshire, Herefordshire, and Wales would demand a visit from the geologist.

The Caradoc sandstone, which is the *upper* member of the great natural group of rocks marked in the map as *Lower* Silurian, is but very slightly represented in the Malvern range; we have around these hills, only the *lowest* and the *very upper* beds of the large series of Lower Silurian deposits, and which in fact form a kind of transition into the Upper Silurian group which rest above. Between, then, the Olenus black shale bed of the Ragged-Stone and Chase-End Hill, and the group which in the Malvern range succeeds below Howler's Heath and Eastnor Obelisk, there is a vast hiatus of many thousands of feet, as all the middle and upper Llandeilo series are wanting, as well as the greater part of the *true* Caradoc sandstone. The geologist, therefore, must distinctly understand that we only possess, as far as we at present know, the bottom, and uppermost or transition beds of the Lower Silurians; the middle group is

wanting! Bearing, therefore, this great hiatus in mind, I would say to those working naturalists who are inclined to follow up our history: Having thoroughly examined the Plutonic rocks and ancient "bottom beds" of the White-leaved Oak and Ragged-Stone Hills, proceed southwards for half a mile, and rest awhile on the western side of the "Chase-End." Discuss your sandwich and the contents of your flask, and if you please, smoke your cigar; but have the goodness at the same time to remember, that in the hill opposite, due west, called Howler's Heath, and in the Obelisk Hill of Eastnor, to your right, will be the best opportunity of studying the geology and collecting the fossils of the *upper* Caradoc beds of the Malvern district. This range of strata is very easily traced by crossing the valley to the hill of Howler's Heath, and following up the sections northward to the foot of the Obelisk Hill. Many shells and corals may be met with by splitting the detached pieces of sandstone which every where lie upon the land; but having examined the quarry of purple sandstone at the top of the hill at Howler's Heath, and the conglomerate beds at the south end, as far as fossils are concerned, I would

not recommend delay, but proceed at once for the Obelisk Hill, in Eastnor Park. On crossing the Ledbury and Tewkesbury road, as we proceed towards the Obelisk, there are two or three spots worth visiting. The first is a quarry near the road side, at the summit of the Holly-Bush pass, which exhibits an interesting section of indurated and altered sandstone resting against the syenite, interlaced by a dyke of trap. This dyke dips to the east.

A little farther down the hill, and close to a cottage-garden on the left, there is by far the best section of the "Holly-Bush sandstone" (the lowest strata of the Malverns) that I am acquainted with. The trap dykes, and the altered sedimentary deposits, all prove that submarine volcanic action was common in the sea-bottom in which these oldest Silurian rocks were accumulated. And those who are acquainted with volcanic grits and the "ash-beds" of Wales cannot help suspecting that the Holly-Bush sandstone is due to the same cause, viz. the igneous dejections of submarine volcanoes spread out over the bed of the sea. The only organic remains hitherto discovered in these beds are the supposititious impressions of sea-weeds. Follow-

ing the road for about a hundred yards towards Ledbury, we see on the left hand a trap boss of greenstone, figured by Professor Phillips in his *Memoirs of the Geological Survey*, p. 57, and which he describes as "in part rudely *prismatic*, and partly in a soft decomposed state, with large desquamated balls." Here we would remind you, that lava poured forth under the sea, and cooled slowly at considerable depths, assumes a very different form to lava ejected at the surface, or into the open air; and in examining the greenstone or trap dyke on the Ledbury high road, the young geologist will do well to bear in mind the experiments of Mr. Gregory Watt, and the *prismatic* forms of the chemist's laboratory. Crossing the high road, and proceeding by Bronsil Castle to the foot of the Obelisk Hill, we may examine four more bosses of trap; and on the side of the lane that runs round the hill, just above them, we come upon the Caradoc beds that we have before made acquaintance with at Howler's Heath (Caradoc conglomerate of Professor Phillips).

As it is our wish to convey information, and point out to the stranger geologist the best localities for fossils, let us pause here awhile,

and examine one or two quarries or rather holes along this little lane or ride which are extremely rich in those fossils that belong to a period which closed the epoch of the Lower Silurians. As we said before, these are the *upper* beds of the Lower Silurian deposits, and indicate a transition into the Upper Silurians, for we find *characteristic* fossils of the lower group mingled with those that tell of a near approach towards that system so well known in the Malvern district as the Wenlock and Ludlow group.

Almost immediately opposite the high-paled gate that leads into the lane from the grass-field above Bronsil Castle, the searcher for Caradoc fossils will see cavities in the bank which look very like the "grubbings" of the geologist. I recommend his first setting to work at *that particular hole*; and when he can get no more stone to split, to adjourn to another cavity where the rock is exposed, on the right, *i. e.* to the north by some hundred yards, and situated near the entrance of the valley that leads to the Gullet and Fair Oaks.

If the ancient seas had never given up their dead, or the rocks unfolded the relics of species

of shells, corals, and other animals that have for myriads of years *died out*; if the surface of the earth had not undergone often and repeated changes, and certain forms of animal and vegetable life had not been introduced as that surface was fitted to the conditions of their being; if it was not in the power of reasoning man to trace step by step the periods of the planet's history, and its exquisite development, as preparing for the future habitation of man,—then would geology have been the “shallow science” the ignorant and bigoted would fain suppose, instead of one of the surest evidences man possesses of the marvels of Creative wisdom. By the time we have ascended the ladder of our history even as high as the Caradoc sandstone of the Lower Silurians of Malvern, we find abundant evidences of life in these ancient sea-beds. In the lowest fossiliferous rocks we must remember that two species of corals—a small crustacean or two, and one shell-fish (*lingula*)—is all the evidence of life we possess through thousands and thousands of feet of sedimentary deposit. Let us see what the beds in the Obelisk Hill will furnish, keeping in view that a vast series of deposits marked on our ladder as the

“Llandeilo series” is wanting in the Malvern group of rocks.

An hour's work at the spots we have mentioned will supply the cabinet of any active stone-breaker with two species of lingula (*Lingula attenuata* and *Lingula parallela*), several other brachiopodous shells, of the genera *Orthis*, *Atrypa*, and *Rhynchonella*, with Annelids and Orthoceratites. The brachiopoda are bivalve shell-fish, which were so abundant in the ancient seas, that we cannot do better than give Mr. S. P. Woodward's description in his excellent treatise on *Recent and Fossil Shells*; and with this work the student will do well to make himself thoroughly acquainted. “The brachiopoda differ from the ordinary mussels, cockles, &c. in being always *equal-sided*, and never quite *equivalve*. Their forms are symmetrical, and so commonly resemble antique lamps, that they were called lampades or ‘lamp-shells’ by the old naturalists: the hole, which in a lamp admits the wick, serves in the lamp-shell for the passage of the pedicle, by which it is attached to submarine objects. . . . Nothing is yet known respecting the development of the brachiopoda, but there can be no doubt that in their first stage they are

free, and able to swim about until they meet with a suitable position. It is probable that in the second stage they all adhere by a byssus, which in most instances becomes consolidated, and forms a permanent organ of attachment. Some of the extinct genera (*Spirifera* and *Strophomena*) appear to have become free when adult, or to have fixed themselves by other means. . . . The lamp-shells are all natives of the sea. They are found hanging from the branches of coral, the under side of shelving rocks, and the cavities of other shells. . . . Of all the shell-fish the brachiopoda enjoy the greatest range both of climate, depth, and time; they are found in tropical and polar seas, in pools left by the ebbing tide, and at the greatest depths hitherto explored by the dredge. At present only seventy recent species are known. . . . Above 1000 extinct species of brachiopoda have been described. They are distributed throughout all the sedimentary rocks of marine origin, from the Cambrian strata upwards; and appear to have attained their maximum, both of generic and specific development, in the Devonian age. The oldest form of organic life at present known, both in the old and new world,

is a lingula." With these observations of Mr. Woodward on these old shell-fish in his mind, the explorer who spends an hour or two at the quarry at the head of "the Gullet" cannot fail to meet with much that will exercise thought and speculation. The lingulas are beautifully perfect, and their fleshy footstalk has alone left no vestige of its presence; they have frequently a metallic tinge, and stand out from the stone in bright relief. They lived in a time, too, when the higher classes of animals,—mammals, birds, reptiles, fishes,—had not even a representative. No land-plant is known to have been their contemporary. The molluscous (shell-fish) tribe and the crustaceous (lobster and crab order), with annelids (sea-worms) and the radiata (corals, star-fishes, &c.), were, as far as we now know, the "sole existences" of the planet during the period when the beds we examine under Eastnor Obelisk were in course of formation. Another very characteristic fossil of the Caradoc formation is a bivalve called by Sir R. I. Murchison *Arca Eastnori* (*Silurian System*, pl. 20, fig. 1^a 1^b); and *Pterinea (avicula) orbicularis* (*Silurian System*, pl. 20, fig. 2) is also not uncommon. These fossil bivalves, or conchifera,

are allied to the oysters and scallops of the present seas, and are more highly organised than the brachiopods we have just considered, and with which they are associated. The teeth of the Arcas (*Nucula Eastnori*) are well marked in some specimens below the Obelisk, and we believe both these shells to belong to a *Lower* Silurian fauna, although connected and associated with Upper Silurian types. When pursuing our researches amid the deposits of the Obelisk Hill, we cannot fail being struck with the organisms every blow of the hammer reveals. The metallic lingula reminds us of those early days of the planet's surface, when lingulas were the first and almost the only denizens of the seas; while other forms of shells connect us with superior beds, that are charged to overflowing with many new and some old friends of old geologists: all of which lead us to the determination, that it is impossible to separate Upper from Lower Silurian rocks, as far as *fossils are concerned*; although these Malvern beds are probably the line of demarcation between the lower and upper masses of the Silurian system.

Other fossils occur, besides those we have alluded to, at this picturesque locality; but it

will be better perhaps to leave their description until we ascend in the series of deposits, and find them more common than they appear to be in the lower Obelisk beds. One of the discoveries made by a member of our Malvern Field Club may not be deemed unimportant by the geologist: it is the detection of a highly-organised crustacean, *Pterygotus problematicus*, in the grey "Caradoc conglomerate" below the Obelisk. This specimen was found by Mr. John Burrow, the brother of our honorary secretary. The pterygotus is believed to have been allied to the king-crab of the West Indies. This crustacean (the *Linulus*) possesses compound and simple eyes, and is altogether very highly organised: I believe I am not wrong in asserting that the king-crab stands at the head of the crustaceans, and it therefore is extremely interesting to find its analogue associated with the trilobites and other crustaceous creatures of the Lower Silurian rocks. Remains of the *Pterygotus problematicus* are very abundant in the Upper Silurian beds (the Tilstones, near Kington); and Mr. R. Banks possesses a fine collection of remains from Hanter Hill, in that neighbourhood. This is, I believe, a solitary in-

stance of the *Pterygotus* occurring in the Caradoc group. Let not the young geologist attempt too much,—one ancient group at a time is sufficient; and those who would examine and inquire to any purpose should never pass on to a second until they have made themselves acquainted with the first, lest geologic history and its records become a “conglomerate” to the mind, and not a well-divided series of truths.

Before we leave the Gullet Pass, let us trace upwards from Fair Oaks Farm a little stream which gushes down the vale, and we shall see beds of *unaltered* Caradoc sandstone (the upper or transition group), resting at nearly a right angle against the syenite. Two years ago I had the pleasure of pointing out this spot to the Rev. T. T. Lewis and the late Mr. H. E. Strickland. The hollies of this little glen are very remarkable, and it is the best locality I know for capturing that splendid butterfly the great Frittilary. I once saw half a dozen upon the wing among the fern and hollows of the Holly Bush Hill, when exploring the geology of this romantic spot; and I have passed many an hour there, without having recourse to the

hammer or "old stones," among trees, blossoms, ferns, insects, and such-like things.

CARADOC TRANSITION BEDS.

These beds, which succeed the Caradoc conglomerate we have just considered, are to me the most unsatisfactory deposits that occur along the Malvern range. The sections are almost invariably in swampy hollows, difficult to find, or hidden by some wood, where you fear being taken up for a poacher; and although in some localities they afford an abundance of fossils, shell-fish, corals, &c., still the very fossils are drifted and worn, and seldom supply a perfect specimen. It is, however, an important series of strata, and should be attentively worked out, as it affords the student the means of tracing the Caradoc conglomerate containing true Lower Silurian fossils, such as *Lingula crumena*, *Tentaculites annulatus*, *Petraia elongata*, &c. upwards, into higher beds with *Pentamerus lens*, also a Caradoc fossil, but which is associated with many fossils that appertain to the Upper Silurian series. Indeed, these uppermost strata of the Lower Silurians may be said in the Mal-

vern range to graduate into the Woolhope and Wenlock beds above.

For the examination of these beds, I would recommend the Somers' Arms, Eastnor, as the nearest station for a fair start and a warm stable. A section with some fossiliferous sandstone occurs at a place called Wain Street, on the Ledbury and Tewkesbury high road; and by walking up the park towards the valley of Netherton and Stump's Wood, the Caradoc sandstone may with some difficulty be traced. In a grass field at the entrance of the valley of Netherton is a quarry of Woolhope limestone, which covers up the upper Caradoc sandstone, and which has been formerly worked, but is now abandoned. A walk from this quarry upwards towards the Obelisk, by the keeper's lodge, will enable the geologist to form an idea of the great thickness of these beds, if he does not add much to his collection. The Caradoc transition rocks occur on the eastern side the Malverns, as well as the western, as mentioned, in the gorge between the Gullet and the Fair Oaks. Professor Phillips also detected them on the east side the Swinyard Hill, and again high up on the Beacon. These beds are to be seen at the Wind's Point,

where the Worcester road crosses the chain to Ledbury and Hereford, and where there is also a fine quarry of syenite. By far the best spot for fossils from this formation is Gunwick Mill, on a brook called the Leigh, and which is really the only place I can recommend,—it may easily be reached from Great Malvern.

The lithological character of the Caradoc sandstone of the Malvern district differs considerably from that of the Woolhope limestone, and affords a good line of demarcation. The student must take care of being led astray; for such exact data do not in reality exist when we extend our researches into distant districts. The great Silurian geologist himself says, "It is difficult to draw any definite line between the uppermost member of the Caradoc formation and the lowest portion of the overlying Wenlock shale;" and it appears that at May Hill the very transition beds we are speaking of are filled principally with fossils of the Wenlock age. Thus we learn from our Malvern data, compared with other evidence, that the Lower Silurian and Upper Silurian are linked together sometimes by a mineral transition, sometimes by an interchange of fossils, but that the upper

beds of the Caradoc transition rocks are on the whole distinct from the lowest Wenlock (Woolhope limestone), and that the beds immediately below them in the Malvern district (Caradoc conglomerate) are undoubtedly to be classed as true Lower Silurians by reason of their characteristic fossils.

THE CARADOC CONGLOMERATE OF MISS PHILLIPS.

We must not pass over one important discovery connected with the Caradoc transition beds, as it is intimately connected with the *state* in which certainly a portion of the Malvern range was elevated. All honour is due to the amiable and intelligent lady who was the discoverer (Miss Phillips, sister of the learned Professor)!

A molten rock alters and *roasts* and bakes limestone into marble, fuses sandstone into quartzose conglomerate, and destroys every symptom of fossil remains. Now, resting against the syenite itself, in many localities we could point out, are the remains of an ancient sea-beach, a sea-shore of the period of the Caradoc transition rock; and this sea-beach contains fossils of that epoch un-

changed and unaltered. Mingled with these fossils are pebbles and fragments of the Malvern syenite, containing the same crystals of quartz and mica, felspar and hornblende, as the rock of the chain. What, then, is more evident and circumstantial than the proof, that; even at the period of the upper Caradoc, the once ancient lava was precisely what it is at the present moment—a hard crystalline Plutonic rock; and that the waves lashed its stony bed, and the ocean-currents detached fragments and crystals from the matrix, and thus mingled the fire-derived materials, with shells and corals that lived and died during the Caradoc transition period. We know something of that period,—we know that no vertebrated animal had been then created, and fossils and relics enable us to trace a history down even to those remote depths of time; but who, when he looks upon the unaltered fossils and pebbly sea-beach against the Malvern syenite, does not reflect that there is yet another question to be asked of bygone years, on a subject still more mysterious, and of ages still more remote;—if, during the upper Caradoc epoch the salt waves washed the Malvern syenite, just as much solidified then as it is now, when and

at what state of the planet was that Plutonic rock *molten* ?

WOOLHOPE LIMESTONE, OR LOWER WENLOCK.

These lowest beds of the Wenlock formation rest immediately on the transition, or uppermost beds of the Caradoc group, and are true Upper Silurian deposits. An examination of the quarries at the south end of the Nether-ton valley, below the wood, which we have before alluded to, exhibits at a glance the relation of these strata to the Wenlock beds above and the transition group below. Its thickness is estimated at from ten to twenty feet. Professor Phillips mentions, that the best and most interesting of all the sections for examining the relations of this deposit is beneath the Worcestershire Beacon, "where the Mathon-Park road crosses the little valley." Other good sections, given by the Professor, may easily be examined by our friends at Malvern; one near Alfrick Pound, another to the north of Storridge Farm; while visitors to the south end of the Malverns may study it below Howler's Heath, near the Glyneh Brook. It has also been cut into by

the shaft for the Hereford and Worcester railroad, on the east side of the Malverns, opposite Winning's Farm. If I were consulted, it is at this spot that I should commence my examination of the Woolhope limestone; and after searching the beds of shale that have been thrown out of the pit for certain trilobites of large dimension, should proceed onwards by the Camp Hill for the picturesque valley of Netherton, where, having well examined the position of the beds, a few hours' work in the spring sunshine would repay the collector for his trouble. The prevailing fossils of the Woolhope limestone are trilobites, and brachiopodous shells of the genera *Leptena*, *Orthis*, *Strophomena*, *Atrypa*, and *Rhynconella*, with several other animal remains; all of which are found in the Wenlock beds above, and we shall allude to them in our description of succeeding deposits. I would here call the attention of the geologist to one particular respecting the Woolhope, or Lower Wenlock limestone, besides its position as resting against the Caradoc transition beds. Wherever I have examined the lowest beds of the Woolhope limestone, whether at Malvern, Woolhope, or Corton, near Pres-

teign, they rest against the Caradoc; and I have always found them charged with the remains of those large trilobites, *Bumastus Barriensis* and *Homalonotus Knightii*. We are aware that these forms are common to the Wenlock formation; but the fact to be noticed is, their *superabundance* in the lowest Wenlock or Woolhope beds. So convinced was I of this fact, that when, some years ago, I visited the Corton quarries, near Presteign, I ventured to oppose the opinion of two distinguished geologists, who held that the limestone there developed was Wenlock; while, from its position, as resting against the Caradoc, and being charged with these particular trilobites, I myself felt convinced it was "Woolhope." The government surveyors have ratified this belief. Precisely the same phenomenon occurs at Woolhope valley; the lowest beds quarried are full of the remains of these trilobites; scarcely a stone is raised that does not contain vestiges of their heads, tails, or bodies, scattered about; while in the upper beds of the same deposit the workmen do not find a *Bumastus* in a month.

The members of our society (Malvern Nat. Hist. Field Club) will call to mind the great

numbers of relics of these same trilobites that we discovered in the Woolhope shale thrown up from the railroad shaft. I believe the same remark applies to the limestone of Barr Beacon, where the *Bumastus Barriensis* alluded to was first discovered; and although many species of shells and trilobites were long-lived and had a great range in time, there is no reason why we should allow great lines of geological demarcation to be questioned and set aside simply because a few species may, either upwards or downwards, happen to run into them. The Barr trilobite occurs occasionally in the upper Ludlow rock, but it was eminently in multitude and perfection an inhabitant of the lowest Wenlock or Woolhope series; and the fact of its being discovered in the Catadoc transition beds would not therefore prove that rock to be an Upper Silurian deposit, any more than the ascent of a specimen or two of the *Pentamerus lens* or *Pentamerus oblongus* into the Woolhope beds would make them Lower Silurians.

Eocene species run into miocene deposits, and miocene into pliocene; but that is no reason why necessary separating lines cannot and should not be drawn. There is a boundary suf-

ficiently distinct; and the same argument holds good as regards the Upper and Lower Silurians.

I have said so much here respecting trilobites, that, for the sake of any geological tyro, I may be allowed to add a few words on their structure and economy. They belong to the crustaceous group of animals, of which crabs and lobsters are familiar examples, and whose skeletons are external: they occur in the lowest fossiliferous rocks, as we before mentioned; and thus, with graptolites and lingulas, are the earliest inhabitants of the planet's surface. The lingula has existed until the present time, but both trilobites and graptolites have for millions of years vanished from the scene; graptolites are unknown above the Silurian epoch, and the trilobite vanishes with the Carboniferous. Many genera and species of these extraordinary animals are known to have existed, and some of them characterise certain deposits: for instance, the little *Olenus* and *Agnostus* of our Malvern black shales are known only in the oldest Silurian slates; and with them we find, in North Wales, another crustacean of the phyllopod tribe, called *Hymenocaris vermicanda* (Salter).

The Silurian rocks are the grand abode of trilobites; for but few species are known in the Carboniferous system. Their structure consists of a crustaceous external shell, divided by grooves into lobes; hence their name,—three-lobed. They vary exceedingly in size and form; the *Olenus* of the black shale is not much larger than a pea, while there are other species from the Woolhope limestone in our museum at Malvern, which would have been sufficient for a moderate man's breakfast; the *Homalonotus Knightii* in some instances must have exceeded a foot in length. Some species could coil themselves, like the woodlouse; others, as the *Homalonotus*, were unable to do so. No traces of legs have been discovered; and it is supposed that, like the footstalk of the lingula, they were fleshy, or cartilaginous, and therefore perishable. The eyes vary exceedingly with the species; those of the *Homalonotus* are small and apparently protuberant, as the eyes of the lobster. The eye of the *Bumastus Barriensis*, that occurs so commonly in the Woolhope beds, is still more remarkable, being apparently protected with a strong lid; the workmen call the eye of this creature "toad's eyes." Again, the structure

of the eyes of several species, as *Phacops caudatus* and *Phacops Downingiæ*, resembles that of insects, and more especially that of the dragon-fly. The eye of that beautiful and well-known insect, and that of the butterfly, house-fly, &c. is composed of many distinct visual lenses.

In the eye of the trilobite, so common in the Woolhope and Wenlock beds of the Malvern district (*Phacops caudatus*), four hundred spherical lenses have been detected. The king-crab of the Indian Seas (*Linulus*) is furnished, like the trilobite, with compound eyes: and "thus," observes Dr. Buckland in his *Bridgwater Essay*, "we find in the trilobites of these early rocks the same modifications of the organ of sight as in the living crustacea . . . in those remote epochs, the marine animals were furnished with instruments of vision, in which the minute optical adaptations were the same as those which now impart the perception of light to the living crustacea. The mutual relations of light to the eye, and of the eye to light, were, therefore, the same at the time when crustacea first existed in the bottom of the primeval seas as at the present moment."

Now the perfect *Phacops Downingia* and *Phacops caudatus*, with their highly-organised eyes, are not uncommon in the beds that succeed the Woolhope limestone, on which we have so long delayed; and the careful searcher among the Wenlock shale and Wenlock limestone may hope, with "careful eyes," to become the possessor of one of those inhabitants of old times, with the eyes and lenses perfect. I have collected many such specimens in this neighbourhood. When, therefore, for the first time, the young geologist meets with these eyes among the lovely valleys and hills where they are found, will he, before they are consigned to the pocket or geological bag, favour them with ten minutes earnest and deep consideration?

An ancient fable tells us of eyes that turned every thing they looked upon into stone. The trilobite's eyes are now stone themselves; but, as we look upon them, we may contemplate a history revealed by those stony organs, of the greatest importance in geologic truth.

May I, for a few moments, be allowed a digression?

Some years since, an eccentric gentleman,

who lived in a frequented thoroughfare in London, determined,—as we now ascertain, by means of meteorological instruments, the amount of rain, &c.,—to ascertain the amount of human curiosity. To carry out this laudable inquiry, he placed immediately opposite his window, on the other side of the street, a small glass casement, over which were written these words: “Passengers are particularly requested *not to look in here!*” The consequence was, that *only* three per cent of the lords of the creation, and not one of the fair sex, passed without looking in at the little window!

Much about the same time, an ingenious book, entitled the *Vestiges of Creation*, made its appearance, and caused a considerable sensation in the scientific world; for it advocated a theory supposed to be long exploded amongst men of science and common sense,—the theory of Oken, Maillet, and Lamarck,—that the higher classes of animals have been developed from the lower: animalcules and infusorial animals into something higher—corals perhaps; corals into jelly-fish or star-fish; worms and barnacles into lobsters; and so on, until fish were developed

into reptiles and birds ; when, at last, asses were developed into monkeys, and monkeys into men !

No sooner had this work appeared, than it was attacked by the geologist, the astronomer, the botanist, and the zoologist. Professor Sedgewick wrote against it ; the celebrated Hugh Miller exposed its fallacies and follies in his well-known work, *The Footprints of the Creator* ; Professor Owen wrote and spoke against its perversion of facts ; and every person whose opinion is worth having, pronounced it to be full of bad faith, bad geology, and bad science generally. Every reader was particularly requested "*not to look in here.*" But what was the consequence ? persons who, to my certain knowledge, never opened a scientific work before or since, *looked in there*, and for months were full of the astounding TRUTH, that electricity was capable of producing infusoria out of *nothing* ; that goslings became rats, and monkeys fools and idiots, we presume, as a link between that class and the intellectual !

One word, then, to the young geologist who finds the trilobite's eye. Unfortunately for the

Vestigian theory, among the very first of created beings appears the trilobite; and it is accompanied by a shell-fish especially adapted to the seas of which it was a denizen. According to Vestigian ideas of creation, the first animals should all have been sponges, animalcules, corals, and jelly-fish; and it certainly is a puzzler, out of which of these the "ingenious author" would develop that miracle of creation, organisation, and design,—the eye of the trilobite. Lingulas possessed no head, and certainly no eyes, to be developed. Surely, then, we learn here an important fact in geologic history, viz. that every thing was *created*, and that the lowliest animal appeared not upon the wide world's surface without the fiat of the Creator. The omniscient Creator gives nothing without its purpose; and in examining the eye of the trilobite, we learn that the sun shone upon our planet in that early period much as it does now. Had there been less light, there would have been less highly-organised eyes. The dragon-fly, with his glorious orbs, soars in the sunshine; the mole and the Proteus burrow in the darkness and the gloom.

WENLOCK SHALE AND WENLOCK LIMESTONE.

The Wenlock shale and Wenlock limestone succeed the beds we have last examined ; the former usually occupying the valleys and slopes, and the latter rising into low hills. South of the Herefordshire Beacon no good sections of the shale can be explored ; but at Colwall Copse, and between Old Castle and Wind's Point, some tolerable sections may be examined. In the neighbourhood of Storridge Farm also, following the advice of Professor Phillips, members of our Field Club have had good opportunities of examining the Wenlock shale. The fossils of these beds, and the limestones above, are very abundant and well preserved ; and the very stones of the fields on the slopes above Netherton valley are, for the most part, ancient shells. After some of the arable land in the occupation of Mr. Lane has been fresh ploughed, a half-bushel bag might be filled with stony brachiopods, such as *Pentamerus linguifer*, *Rhynchonella nucula*, *Strophomena euglypha*, &c. The trilobites, *Phacops caudatus* and *Phacops Downingia*, may be occasionally met with ; the former like a hedgehog rolled up, with its tail

and mouth in close proximity. The most remarkable organic remains of this division are the corals; for in some places, Dormington Wood for instance, in the Woolhope valley, the rocks are perfectly crowded with them; and some noble specimens, from Colwall Copse, may be seen in the collection of the Malvern Natural History Field Club. We would also especially draw attention to the fine *Orbiculas*, from the same locality, obtained by the Messrs. Burrow. We believe the species to be "*Orbicula Forbsii*." No group among the rocks of the Western Malvern district can be more easily traced than the Wenlock limestone; and as beautiful scenery, amongst lovely hills and woods and running streams, is generally combined with a full bag of fossils, I confess to a great *penchant* for Wenlock shale and limestone.

Brock Hill and Colwall Copse are always within reach of the visitor at Malvern; and many corals, with brachiopodous and gastropodous shells, and even trilobites, will reward the careful searcher. Purlieu Lane, and other old and hollow ways between Mathon and Malvern, are worth a visit; and a well-known botanist and member of the Field Club may

also be stumbled upon, seeking in deep recesses for "*Lathræa squamaria*" and other shy plants, where "thick masses of verdure, from pollard oaks and battered hollies, overspread the twilight scene ; and old boles and mossy roots are covered with the untouched hoary mould of centuries" (Lees's *Botany of the Malvern Hills*). The stranger must not expect to find all the rare fossils awaiting his collection, or to kick over trilobites and orbiculas at every step he takes. The rarer fossils, like rarer plants, are not to be obtained without a painstaking search in particular localities. For instance, if I particularly coveted an orbicula, I should cultivate the society of our honorary secretary, Mr. Burrow, and the woods and quarries of Colwall Copse. The vice-president of the Field Club (Rev. F. Dyson) has a remarkable *penchant* for trilobites, which he manages to pick up where no one else can. Purlieu Lane is good for corals, Netherton Valley for brachiopodous and other shells. That lovely and most romantic hill, called the Ridgeway, which leads from the Ledbury highroad to Eastnor Castle, has several quarries on its sides well worth visiting, and from which I have obtained my best specimens

of *Phacops caudatus*, with head and tail attached. Perfect specimens are rather rare in the Malvern district; though why the almost universal separation of head and tail occurs has never, I think, been sufficiently explained.

At the southern extremity of the hills, Coneygre Wood is a good locality for studying the Wenlock limestone; the Ledbury quarries are also well worth a visit. The student will soon learn the great lesson geology teaches on the wearing and degrading action of former sea-currents on former surfaces, when studying the physical character of the shales and limestones now before us. The stratified deposits tell their own tale: how they once lay above the Malvern syenitic ridge, and have been upheaved, dislocated, and tossed back; and then again, the hills of hard limestone, and the dale worn in the soft shale, bear witness to the ages of denudation, when ocean-currents scooped out and washed away the softer masses of the upcast strata, and left the limestone hills, preserved by their harder materials, evidences and memorials of the "deep sea waves" that have for myriads of years ceased to murmur there.

The ocean has often been a favourite em-

blem of eternity amongst poets ; but the fact is, that at every step, we tread upon sand and mud and gravel, that once lay in the profound depths of a former sea. Old Ocean was, and is, just as changeable and fluctuating as all else on this planet's surface.

Mrs. Hemans, speaking of what we should behold if the present sea-beds were elevated, and we could look upon their relics, says, in her own exquisite language :

“ Yet more—the depths have more ! The waves have
roll'd

Above the cities of a world gone by ;
Sand hath filled up the palaces of old,
Sea-weed o'ergrown the halls of revelry.
To them the love of woman hath gone down ;
Dark flow their tides o'er manhood's noble head.”

And though our steps do not traverse the site of human graves, who can deny that we tread upon the relics “ of a world gone by,” when we ramble among the Silurian hills and valleys of the Malvern district ? We walk upon the beds of former seas, and on the historical records of their inhabitants,—the remains of numerous testaceous and other animals, that make up immense accumulations, such as the

Wenlock and other limestones ; and if we think at all, reflection must bring home to our minds this great truth, that He who made us made them ; and that in His own good time “ creation succeeded creation,” until intellectual man was summoned upon the scene, to appreciate the terms Eternity, Wisdom, Omnipotence, and the vast indescribable power of foreseeing future good through endless ages !

I am not about to describe the geology of the Woolhope Valley, for that would demand a chapter of itself ; but to the geologist it must ever be classic ground, as connected especially with the labours and investigations of Sir R. Murchison. And to those who have time and opportunity, I would say, without hesitation,—Go to the Foley Arms, Tarrington, between Ledbury and Hereford ; ensconce yourself, with the Survey maps, hammer, chisels, sandwich-box, and other appurtenances, in “ Sir Roderick’s room ;” and rest assured that a week may be spent at that village hostelry, in examining the geology of that remarkable district, and enjoying the picturesque and most peculiar scenery, without fear or hazard of *ennui*.

The coach-road runs at the base of the hills

that bound the Woolhope "valley of elevation;" and the consequence is, that not one traveller in five thousand is aware of the beauty of the scene beyond. Once again, then, we recommend climbing the hill above Stoke Edith and the Foley Arms; then all we need say is, "*Circumspice!*"

Imagine the whole district before you to have been elevated in the shape of a pear, in a convex form, the strata of the opposite hills joined and their masses of limestone arching over the central nucleus of Haugh Wood, —you have an example of an elevated cone that arose, as did the Malpais in Mexico, A.D. 1759. Plutonic masses and earthquake agency upheaved the Silurian beds into this cone-like form. Then came another power into action; and denudation, by sea-waves and currents, swept away every fragment of the mass of rocks that formed the dome or roof, tore up the softer shales of the valley, and rendered the district before us, as Sir Roderick Murchison himself declares, "the finest known example within the British Isles of a valley of clean denudation as well as of elevation" (*Siluria*, p. 118). It is not in a day the geologist will comprehend the

wonderful physical revolutions this valley, or rather series of valleys, have undergone; or the clear evidence of convulsion, dislocation, and after-denudation that is here exhibited.

But we must hurry on to one or two favoured localities for fossils, worth a visit and an hour's work. The rock we especially choose belongs to the division of the Wenlock limestone. Immediately in front of the road that crosses from the park by the "Cock Shoot," are the limestone quarries of Dormington Wood, a favourite meet for many members of the "Woolhope Club,"—the Herefordshire Naturalists' Field Society,—so named in honour of Sir R. Murchison. The Wenlock limestone here is one mass of corals; and my object in recommending this spot to my fossil-collecting friends is, that they may at one journey enrich their cabinets, from the shale-heaps, with the most perfect, beautiful, and varied specimens of the corals of the Wenlock group that I know of in my whole experience as a geologist. With tolerable success, almost all the specimens figured by Sir R. Murchison in *Siluria* (pages 212 and 213) may be obtained, as well as many of the Bryozoa (page 215). Many fossil shells and encrinites are to

be met with; and *Strophomena euglypha* will not easily be forgotten, when found with its still brilliant pearly nacre glistening in the sun.

The leading object of a visit to Dormington Wood is to call attention more especially to those old vestiges of life, the Wenlock corals, and the evidence they afford the geologist on the subject of primeval history.

The history of the coral-building animals is well known, also their great diversity of form and structure as they exist in the present day, and how the stony substance called coral is a secretion from a fleshy animal substance, to which the hard coral is the skeleton or solid support. The coral family are principally inhabitants of the ocean, and they bear a very important part in the physical economy of our globe. To such an extent, even in the present seas, do their masses multiply, that groups of islands are continually forming; and coral reefs stretch away in southern latitudes for many hundreds of miles. The coral reef is gradually elevated above the level of the sea; land is formed, where sea-birds haunt and seeds are drifted; trees and plants take root, and man

at last finds a resting-place on the "once living pile:"

"The mausoleum of its architects,
Still dying upwards as their labours clos'd,
Slime the materials; but the slime was turn'd
To adamant by their petrific touch.
Frail were their frames, ephemeral their lives;
Their masonry imperishable."

Montgomery's "*Pelican Island*."

Some important discoveries have been made by Mr. Charles Darwin on the subject of coral reefs and coral animals; and to those unacquainted with it, we heartily recommend the perusal of his *Journal of Researches* during the voyage of the *Beagle*.

Mr. Hugh Miller gives a graphic description of the manner in which, after a day's work among the fossil fishes of the Old Red sandstone, he would spread out his treasures upon an adjacent rock, and then reflect upon their history. Will the young geologist follow his example with his corals at Dormington Wood?

Their present burial-place is far from the nearest sea, and raised into hills. What but the earthquake and volcanic agency could have accomplished this? Then, as regards the materials

of the limestone,—a microscopic examination shows that every particle once passed through the laboratory of life; and the thickness of the Wenlock group in the Woolhope Valley is not under 500 feet.

It is impossible to see the myriads of once living forms that every where lie on those banks of shale, tossed out in excavating the limestone, without reflecting that those skeletons of the dead form whole hills, often now the site of human abodes and human industry. The "Old Stones" which compose those ancient coral reefs, build houses, churches, nay, even give life to future vegetables, and thus to future animals.

The lime-kilns at Dormington Wood, and the vapour and thick haze that always hovers above them, are not without their lesson as regards the future agency of corals and animals that lived in the remote ages of our globe. The coral rock, heated, is decomposed, and separated into its component substances, carbonic acid and lime. Now carbonic acid is one of the principal constituents of the food of plants, and the green parts of all plants absorb it from the air. The carbonic acid set free, even at the Dormington quarries, must, then, have its influence on the

vegetable kingdom ; lime, too, in the shape of manure, is a very important ingredient to fertility. Surely, then, Wenlock limestone, and Wenlock shale, and Wenlock corals, may answer strange questions, tell strange tales.

CHAPTER III.

Lower Ludlow rock and shales—Fossils of, near Eastnor Castle—Orthoceras, Phragmoceras, and Lituite of—Description of Cephalopods—Graptolites of Lower Ludlow, found near Dormington Wood by Mr. Scobie—Aymestry rock, at Doghill, near Ledbury—Lingula Lewisii—The ladies' quarry—Fish-bones and scientific friends—Annelids—Cornulites serpularius—The haunt of *Pentamerus Knightii*—Rev. T. T. Lewis on Upper Silurians—Landslip at Dormington, near Hereford—Nest of the water-ouzel—Encrinites and Crinoidal animals—A few species still existing—Cystideans—Upper Ludlow shale—Fish-remains at Hales End and Mathon Court—Upper Ludlow fishes the first of their class—Sir R. Murchison on the earliest ichthyic remains—Seeds of land-plants discovered in these beds by the late Mr. Hugh Strickland at Gamage Ford—Hagley Dome—*Pterygotus problematicus* discovered here by Mr. Scobie—Phenomena of the transition beds—Downton sandstone.

LUDLOW ROCKS, LOWER LUDLOW ROCK AND SHALES.

THESE grey shales, which succeed the Wenlock limestone, are, in the Malvern district, not less than 700 feet in thickness. They are grouped

by Sir Roderick Murchison with the Ludlow rocks above, rather than the Wenlock rocks below them, because "every where in the typical districts of Shropshire and Herefordshire these shales occupy the base of the escarpments of the same ridges of which the harder masses of Aymestry limestone and Upper Ludlow rocks form the summits and outward slopes" (*Siluria*, p. 126). Near Malvern they occupy the space between Colwall Copse and Brockhill. Proceeding southwards, the course of the Lower Ludlow shales may be traced at several good sections, of which I need only mention that below Mathon Lodge, by Bank Farm, and the valley between Ockeridge Farm, the residence of Mr. E. Pope, and Chance's Pitch. Fossils are abundant near Eastnor Castle, where I have obtained the bivalve *Cardiola interrupta*, a characteristic fossil very abundant in the Ludlow district. This species is found in the Lower Silurian deposits also. The organic remains are, as would naturally be supposed, much the same as those in the subjacent Wenlock limestone; and we find at Eastnor many Wenlock fossils, such as the brachiopods *Strophomena depressa*, *Atrypa reticularis*, &c.

There are, however, other and higher forms of shells, which give to these shales a distinct character; especially those chambered shells known by geologists under the names *Orthoceras* (*orthos*, straight; *ceras*, a horn), *Phragmoceras* (*phragmos* a partition, and *ceras* a horn), and *Lituities* (*lituus*, a trumpet). For two very characteristic species of these shells, as allied to the Lower Ludlow shales, *Orthoceras Ludense*, and *Phragmoceras pyriforme*, I am indebted to the politeness and *rockwork* of Mrs. E. Pope, of Ockeridge Court, Eastnor. Orthoceratites are common in the Lower Silurian deposits, and range from strata of the age of the Llandeilo flags to the Carboniferous or mountain limestone, where they disappear for ever. The *Orthoceras*, *Phragmoceras*, and *Lituities*, were all cephalopodous animals, and belonged to a class of highly organised shell-fish, of which the pearly nautilus is a living example. Cuvier applied the term cephalopod, from their having their feet or arms attached to their head, as the cuttle-fishes. From their superior form, habits, and organisation, the place of the cephalopod is at the head of all the molluscous class of animals, and they rank next to fishes, to many of which, how-

ever, they may be considered as superior, and even make them their prey. The Nautilus and Argonaut of the present seas have external shells, large eyes, an organ for hearing, mouths surrounded by fleshy arms or legs, moved by innumerable nerves, and which bend in every direction; with these organs they seize their prey, and fix themselves strongly to any thing they wish to lay hold of. They possess jaws like the mandibles of a bird, a brain, and remarkable respiratory organs, with a siphon or pumping-apparatus, by means of which they are enabled to ascend to the surface or sink to the bottom of the sea. And such was the fashion and economy of the creatures called Orthoceratites, &c. whose fossil remains are so abundant in the early seas.

The Orthoceratite has been likened to a straight nautilus. They grew to a great size, and some specimens in the possession of the Rev. T. T. Lewis, of Bridstow, must have been upwards of five feet in length. One remarkable specimen in that gentleman's cabinet is full of small orthoceratites, no doubt young specimens drifted into a dead shell. Sometimes all trace of the shell is entirely gone, and the siphuncular

beads alone are left. In the early days of geology these beads were for a long time a puzzle, —they constituted a kind of stomach-pump. Mr. Woodward says that it is probable that the cephalopods of this family were not able to withdraw themselves completely into their shells, like the pearly nautilus; and that they must have held a nearly vertical position, head downwards, on account of the buoyancy of their shells. Orthoceratites have been considered as the “scavengers of the ancient seas;” and when they ceased to exist, their place was taken and their office filled by Ammonites, Nautili, and Belemnites.

It appears that above 1400 fossil species, belonging to that order of cephalopods of which the Nautilus is a representative, existed in the ancient seas, while the nautilus is now the only living representative of a class once so numerous in genera and species. The Phragmoceras, or pear-shaped orthoceratite, is common enough in the neighbourhood of Ludlow. I cannot recal to mind ever having seen more than two or three from the Malvern district, and the best of these specimens was from the afore-mentioned rockwork at Ockeridge Farm, where, although

surrounded with pink and white crystals of carbonate of lime, I fancied that it would look still better in my cabinet, and therefore begged it from the mistress of the house and rock-work. Professor Phillips mentions finding one at "Pine Farm." The *Lituito*, a whirled orthoceras, is also abundant at Ludlow; but I have never yet detected one in this neighbourhood, nor am I aware that this fossil has been found by any one in the Malvern district except the Professor himself.

This appears to be the place to notice the *Graptolite*; as the only Malvern locality for this animal, so common in the Lower Silurians, is at Eastnor, beyond the Castle, in the Lower Ludlow shales. In the Woolhope district, under Adam's rocks (Backbury Hill), on the slope between that spot and the Dormington quarries, very perfect specimens of *Graptolithus Ludensis* may be obtained; they were first discovered in that district by my friend the late honorary secretary of the Woolhope Field Club, Mr. Mackay Scobie. These singular forms, which give one the idea of a fossil pen, were zoophytes related to the genera *Virgularia* and *Pennatula*, of which the living animals inhabit muddy sea-

bottoms. There are many of these extinct forms now known, and they serve to mark the Silurian system of life, for they are not found in any deposit later than the Silurian. They appear with the first forms of life, the *Lingula* and the *Olenus*, and even afford information as to whether the rock be Upper Silurian or Lower. The *Graptolites* of the Lower division have the teeth or serræ on *two* sides, while the Upper Silurian *Graptolites* have the teeth only on *one* side. It is important to mark these characteristics, as in many instances they furnish the geologist with safe criteria of the age of rocks. "In Sweden, *Graptolites* so abound, as to give a highly bituminous character to the lower (Silurian) strata." (*Siluria*, p. 47).

AYMESTRY ROCK.

When looking westward from the Malvern range towards Cradley, Hopend, and Ledbury, the long ridges of wood which mark the course of the Aymestry rock are very conspicuous. This deposit was named by Sir Roderick Murchison after the village of Aymestry, in Herefordshire, where the Upper Silurians had been

worked out by the Rev. T. T. Lewis, of Bridstow, near Ross. In the Malvern district the contortions of these strata are very complicated, and beyond our present scope to entertain. They cannot, however, be mistaken, as they rise in sharp, clear ridges, at the western border of all the Malvern Silurians. A most interesting section occurs near the town of Ledbury, close to the Dog Hill turnpike, where the dip is nearly perpendicular; and this is a capital locality for obtaining the fine species of lingula (*Lingula Lewisii*), so named in honour of our friend and Honorary member just mentioned. I have occasionally seen this fossil "knock out" of rich nut-brown hue, and it then stands out in clear relief from the dark blue stone. The district of Hope End also affords many fossils, while the scenery alone well repays a visit. There is a quarry, of the representative of the Aymes-try rock, close to the turnpike-road at Chance's Pitch, and so easy of access, that we may call it the *ladies'* quarry; it affords the fat round-looking *Rhynconella Wilsoni*, and other fossils. Only the surface of the rock is quarried. A friend of mine once did me the favour to send me from this place a very remarkable "fish-

bone ;" and as such finds will occur amongst our most scientific friends, I may as well describe the " fish-bones."

On the surface of the slabs raised in this quarry there not uncommonly appears a brown, flat, shining, carved, ribbed-looking *thing*, not certainly unlike a " fish-bone," though a very crooked one. The geologist, then, must beware here of " great discoveries," and not rashly pack off a hamper of " fish-bones" for the investigation of London *savans*; the brown shining thing is simply the tube of an annelid (*annulus*, a ring), an ancient sea-worm with a shelly tube, a tribe which ranks at the very bottom of the *annulose* order, and certainly has no right to aspire to that of fishes. The worm-shells inhabit tortuous tubes, and the shape of the shell imitates the windings of a worm. *Serpulites longissimus* is the name of our friend at Chance's Pitch; it is a common fossil, and is characteristic of the Upper Ludlow rocks. Annelids of different genera and species abound in Lower and Upper Silurian strata. They rejoice, too, in euphonious names, such as *Cornulites serpularius*, common in the Wenlock limestone, and especially the Woolhope, at Scuterdine, near Mordiford, Here-

fordshire; *Tentaculites ornatus* is also an exceedingly common annelid.

I cannot close this notice of the Aymestry rock without recommending a visit to Aymestry itself, the haunt of *Pentamerus Knightii*, and one of the most classic spots to the follower of the hammer. The limestone occupies the picturesque gorge of the Lugg, which contains some of the finest trout and grayling in England, that relish exceedingly after a hard day's geology. It was in this neighbourhood that Mr. Lewis was enabled to define the Upper Silurians, to class them by means of their fossils, and thus to contribute very materially to the foundation of the glorious "Silurian system." The masses of that most noble of brachiopodous shells, *Pentamerus Knightii*, are here most remarkable. These fossils are to be seen amongst my collection at the Malvern museum, from the Woolhope district (Bodenham).

The great landslip near Dormington is a Herefordshire lion, and occurs on the side of the Aymestry rock. The Wonder at Marcle is another of these slides of earth. The landslip at Dormington is good for *Pentamerus galeatus*. Our friends must not suppose that the geologist

observes nothing but his "everlasting stones." I was geologising last summer at Aymestry, and with "stones" managed to combine the loved pastime of old Isaac Walton. In the heat of the day the fish declined every bait I could offer; and having heard that *Dreissena polymorpha*, the well-known imported shell-fish, had found a habitat in the Lugg, I laid aside my rod, and commenced a search which proved unsuccessful. In searching among the large stones and roots I struck my hat against an overhanging stump, and out flew the water-ouzel. On examining the moss-grown bough, I discovered its nest; but so beautifully was it concealed, that had I not seen the exact spot from which the bird flew, I might have looked in vain. The nest was formed like that of the common wren, but with the entrance underneath; and so precisely did it imitate the surface of the stump, and so exactly was it composed of the same materials, that the most vigilant eye could not discern a shade of difference. Within were four white pellucid eggs, so clear that I could see the yellow yoke. I don't like birds'-nesting,—it makes one think of one's own little birdlings at home,—so I left the nest of

the water-ouzel unharmed. Although merciful to the feathered tribe, I confess no compunction towards the finny ; and I think the geologist of Aymestry will recollect on that occasion taking home a very handsome basket of trout. May he long live to enjoy many more such !

Before we close our notice of the Aymestry rock, we must not forget the remains of a tribe of plant-like animals, which were attached by roots to rocks, and abounded in the Silurian rocks, more especially in the Wenlock limestone,—I allude to the Encrinites and Crinoideans, so called from the blossom of the lily, which their converged arms imitate. These singular creatures belong to the class Radiata, the lowest in the animal kingdom, and which comprises sponges, animalcules, corals, crinoidal animals, jelly-fish, echini (sea-urchins), star-fish, &c. They possessed prehensory organs, or arms, surrounding the head or mouth ; and, as the cuttle-fish grasps, pulls down, and devours the more highly-organised fish, so it appears did the encrinite seize and devour its superior—the shell-fish. A most interesting engraving, in *Siluria* (page 219), depicts a shell tightly embraced by the arms of a crinoid, and

with the proboscis inserted into the shell. The stems of crinoideans consist of numerous joints, called by the workmen fairy rings; these stems were united by a kind of cartilage which perished on the death of the animal, and hence probably the mutilated state in which the Encrinites of the Silurian and Carboniferous rocks are scattered through the beds; perfect specimens being rare. A few species of these animals are known to exist in the depths of the West Indian seas. The joints of their flexible columns are very abundant in the Malvern Silurians; and some beautiful specimens are to be seen in the cabinet of the Misses Bright, at Brand Lodge, from the Wenlock limestone of Evendine Street. Crinoids make their appearance in the Lower Silurian rocks of North Wales. Allied to these are other remarkable animals of the class Radiata, called Cystideans, a kind of sea-urchin with a pedicle or footstalk. Specimens have been found in the Wenlock limestone of Malvern, but are very rare. Two species of star-fish are known in the Lower Silurians; and several in the Upper Ludlow rocks of Kendal have been discovered by Professor Sedgwick.

UPPER LUDLOW SHALE.

In the Malvern district, this deposit is less interesting than in almost every other locality that I have seen it. Its upper beds constitute a "Transition" rock. It may here be as well to mention at once what we mean by a Transition rock, and Transition epoch.

There appear to have been certain periods in the history of this planet, when, as regards the system of life, and the animals that inhabited the surface, an almost entire change took place. Much mystery always has, and, I suspect, always will attach to these phenomena; sometimes they are supposed to have been owing to violent changes in the physical conditions of the planet, and to alterations effected by the upheaving due to volcanic action, and the consequent elevation and depression both of the land and sea-beds. No doubt an alteration of level, by means of the volcanic forces within, *now* produces alterations in the accumulation of *débris* in the sea-bottom; sea-currents are diverted, and a thousand changes take place, which we are not aware of, because we cannot see what is now going on beneath the waves. In

geology, we learn that these changes *did* take place throughout large districts, and that whole tribes and races of animals and plants ceased to be, and certain forms of life were extinguished, never to be renewed.

Such periods, and the formations and strata that reveal the evidence of such changes, are called by the geologist Transition periods, and Transition deposits. Such were the *upper* beds of the Upper Ludlow shales, with which we have now to deal. Such were the upper beds of the Old Red sandstone group, that graduate into the Carboniferous epoch; but with this ever-to-be-remembered fact, that scarcely a relic of animal life passes the boundary group! A boundary-line still more remarkable occurs in the Permian group, which succeeds the Carboniferous; for of all the thousands of Palæozoic forms that for myriads of ages swarmed in the seas and flourished upon the land during the Palæozoic epoch, not one is known above it. The graptolites and trilobites of the Silurian epoch; the enamel-cased fishes of the Old Red sandstone; the reptilian fishes, plants, shells, and corals of the Carboniferous period, vanish for ever from the scene, and their places are

taken in the Triassic epoch, which succeeds, by other forms created to supply their places.

In examining the Upper Ludlow shale of the Malvern district, and marking its transition into the Old Red sandstone group above, we particularly recommend the quarry at Hales End Farm, which shows all the beds, from the Old Red sandstone and Downton beds, through the Upper Ludlow series. Another good quarry is that near Hall Court; and these shales at the back of Barton Court (the residence of Reynolds Peyton, Esq.) are highly fossiliferous. *Chonetes latus* (*Leptena lata*), a brachiopod allied to *Productus*, is very abundant; as also many spiral shells (gasteropods), *Plurotomaria* and *Murchisonia*. Bivalve shells, such as *Cardiola* and *Orthonota*, may here be met with, chiefly as casts.

The most important fact connected with the Upper Ludlow shales remains yet to be told. Near Mathon Court, and at Hales End, Professor Phillips has detected the remains of fishes (*Onchus*); this is a very important discovery, as it connects these beds and their fish-fossils with the same group at Ludlow, Hagley, Woolhope, May Hill, and even to the Severn, at Pyrton Passage. "Fourteen years have now

elapsed," says Sir R. Murchison, "since I proclaimed that the fishes of the Upper Ludlow rock appeared before geologists for the first time as the most ancient beings of their class; and all the subsequent researches in the various parts of the world over which Silurian rocks have been found to extend, have failed to add to or modify this generalisation" (*Siluria*, 239): and doubtless this is the case. Remains of fishes have often been described and quoted from lower beds; but upon examination they have all turned out to be apocryphal, like our fish-bone of Chance's Pitch; and we have no evidence of the existence of fishes upon the planet's surface until that period of which the Upper Ludlow shale is a representative. Although very poor in the immediate district of Malvern, this Ludlow bone-bed, the earliest known indication of vertebrate life and of terrestrial vegetation upon the surface of the planet, may easily be examined within the limits of a drive. Mr. Henry Stone was with the late Mr. Hugh Strickland and myself when Mr. Strickland discovered in this bed the seeds of land-plants, described by Dr. Joseph Hooker in the *Proceedings of the Geological Society* for Dec. 1, 1852. The spot

is to the north of the Ross and Ledbury high-road, at a point between Lyne Down and Gamage Ford. The bone-bed crops out on the side of the lane, on the left hand as you ascend the hill, and is a black decomposing mass, full of remains of a most interesting character,—*the first fish and first land-plant.*

A still more interesting section, exposing this remarkable bone-bed, and other data of geological interest, is within reach of the Malvern geologist,—I allude to the protruded mass of Upper Ludlow rock at Hagley Park, Lugwardine, Herefordshire, described by the late Mr. Hugh Strickland in the *Quarterly Geological Journal* for Nov. 1852, vol. viii. This remarkable protrusion of a little dome of Upper Ludlow through the Old Red sandstone of Herefordshire, was first discovered by the late Mackay Scobie, Esq., of Hereford; and having paid with him a visit to the spot, I had the pleasure of inducing Mr. Strickland to make a more complete examination, the result of which was the paper alluded to above, which gives an admirable description of the dome, the organic remains, and the other phenomena that are there developed. The bone-bed may be detected at this

quarry with very little care; it is a thin gingerbread-looking stratum, at the very point where the Upper Ludlow shale is joined by the yellow Downton sandstones that rest above. Below is a grey bed of shale, full of fossils; and above a yellow sandstone, with plates of mica, and many fragments of carbonised sea-weeds. I do not know a better example than these Hagley beds, of the junction and transition rocks of the Old Red sandstone and of the Upper Ludlow rocks. It is, however, right to mention, that it is now generally believed that this "bone-bed" consists principally of the remains, not of *fish*, but of crustaceans, some of which were very highly organised. It was at Hagley that my lamented friend Mr. Scobie found that fine specimen of *Pterygotus problematicus* described in the *Journal of the Geological Society*, Nov. 1852, and which is in the cabinet of Mrs. Hugh E. Strickland, at Jardine Hall. The limbs of this crustacean had not before been discovered. As we have before said, the *Pterygotus* was a gigantic kind of lobster allied to *Limulus*, but differing, Mr. Salter informs us, "in having the segments of the abdomen freely articulating with each other." I have seen finer specimens of the *Ptery-*

gotus in the cabinet of Mr. R. Banks, at Kington, than even that so ably described by Mr. Salter.

It is necessary, then, to remember, that the remains of *fishes* in the Upper Ludlow bone-bed are scarce, and most of the remains must be referred to fragments of crustaceans. The shirt-stud-looking bodies are, however, the placoid scales of the most ancient of all known fishes; *Onchus tenuistriatus* and *O. Murchisoni* are "veritable fish-defences:" there are an abundance of coprolites in this bed at Hagley, and also at Gamage Ford. The first created fishes, as far as our evidence at present extends, exhibit no argument in favour of Vestigian development. The Upper Ludlow fish, though minute, are of the "*highest order*," no development from a trilobite into a fish, no monkey-into-man transition. The first fish was a *bond-fide fish* of the most "elaborate organisation."

Those who visit the Hagley Dome should first examine the Bartestree trap-dyke of greenstone; it is near the turnpike-road, and may be taken on the road to the "dome" of Hagley; it cuts through and alters the Old Red sandstone, and is a good instance of the dislocation of the surrounding rocks, and a crevice filled with vol-

canic matter that has roasted the Old Red sandstone with which it has come in contact.

The geologist would be wanting in gratitude if he did not thank the owner of the land, Robert Biddulph Phillips, Esq., for his kindness and courtesy in allowing the interesting section in his grounds to remain open for the investigation and inspection of the observer. When we reflect on the vast number of square miles that we cannot doubt this "bone-bed" is spread over,—for it has been traced from beyond Ludlow to the Velt House, and even to Pyrton Passage on the Severn, a distance of not less than forty-five miles,—when we recollect the important fact of its occurring just at the transition-line of two great epochs, the end of the Silurian, and the commencement of the Devonian, or Old Red sandstone epoch,—when we observe the mass of dead remains of crustaceans and fish crowded together in that single stratum,—when, I say, we connect these phenomena with others of a like character, such as the occurrence of the Keuper bone-bed at the end of the Keuper period and the base of the Lias,—I really do not see how we can avoid coming to the conclusion, that this amount of sudden death, suc-

ceeded as it is by a total change of the conditions of life, was connected with some vast physical alteration of certain portions of the planet's surface, owing most probably to earthquake and volcanic agency, that occurred during the Upper Ludlow period, and which wrought the extinction of the Silurian forms of life, and the change in the mineral characters of the formation we perceive in the beds above.

DOWNTON SANDSTONE.

"The Downton sandstone," says Professor Phillips, "stands as a group of passage-beds, the lower part really allied to the Silurian, and the upper part really allied to the Old Red stratifications. With these passage-beds the long Silurian series terminates in the Malvern region."

These beds are easily recognised, and are much used by the Malvern builders; being easily worked, and a most excellent stone for their purposes. The Downton beds are now considered by Sir R. Murchison to be the upper portion of the Ludlow formation, for in other localities they contain the common fossils of the Upper Ludlow rock. In the quarry at Hall's

Court they are well developed, but only the lowest beds contain fossils. At Hagley Dome, Gorstley, near Newent, and many other places, these junction-beds may be studied, and especially on the Ross and Gloucester railroad, at Flaxley, where Sir R. Murchison and Mr. Strickland detected the bone-bed. The globular seed-vessels declared by Dr. Hooker to be seeds of a plant "allied to *Lycopodiaceæ*," are to be met with at all these localities. I am not aware that they have been found in the Malvern district, although much carbonaceous matter and traces of plants occur near Hall's Court and at Hale's-End Farm. On referring to my cabinet, I find the specimens from these beds in the Malvern district few and far between; and the characteristic little *Lingula cornea* is also wanting, although I possess many from other localities. In this slight sketch of the geology of our rocks, no one feels more than myself the impossibility of doing justice to a subject that requires so much attention and real study. The geology of the Malvern Hills fails to furnish us with any but the fag-ends of the long history of the Lower Silurian period; and whole tribes of animals that are to be met with in the true Si-

lurian district are not to be found on the flanks of the Malverns, as the beds that contain them are not exposed. Throughout the immense period of the Lower and Upper Silurian, families and genera were created and ceased to be, for the graptolite is unknown above the Lower Ludlow shales. The geologist who works only amongst the Lower Silurians of Wales, if set on for the first time amongst the Malvern beds, would find the species, with but few exceptions, entirely new; and yet again,—a point of startling interest,—the Upper Ludlow rock stands forth a witness to the fact, that a time at last arrived when nearly the whole Silurian creation ceased to exist. Through all this maze, we cannot hope to do more than form a desire or a taste for investigation into truth; and if we induce one person to study the works and examine the evidence adduced by some of the great masters of the science, Lyell, Murchison, Phillips, Sedgewick, De la Beche, and others, we shall not regret having recorded our own observation and experience. Altogether there are few districts in England that better repay the geologist for his time and attention, nor do I know any spot that possesses more compre-

hensive phenomena, whether they relate to the physical branches of the science, or the number of fossil remains.

To one unacquainted with Silurian geology and fossils the neighbourhood of Malvern has especial charms ; and he will hardly ramble amongst our hills and dales, and study their history, without confessing that there are strange tales attached to our " Old Stones."

CHAPTER IV.

Old Red sandstone—Contact with Downton sandstones—Geologic view from the summit of the Worcester-shire Beacon—Lowest Old Red deposits—Change in mineral character of the sediments—Old Red sandstone of Mr. Hugh Miller—*Pterichthys* of the Lowest Old Red—Fossil shells of Devon—*Trilobites* scarce—Fossil shells of Devon and fishes of Russia synchronous—Cornstone, or middle group—Cornstone hills of Herefordshire once continuous—Organisms of the Cornstone group—Hugh Miller's description of—Fossil shells in this deposit wanting in Herefordshire—Quartzose conglomerate of the Upper Old Red—Distinct in its organisms—Enormous denudation of the Old Red sandstone, as exhibited in the Bloreng, Scyrrid, &c.—Carboniferous deposits once above the whole of Herefordshire—Pen-cerrig-Calch, or the hill of the limestone peak—Once connected with the Bloreng, the Clee, and the Forest of Dean—Hints upon a geologic tour of the Old Red in Herefordshire—Dog Hill near Ledbury, Ledbury Church-Wall Hills—Trap-dyke at Bartestree—Lowest Old Red beds altered by—Church at Bartestree—Quarry at Lugwardine—Herefordshire botanists and Hereford Museum, Woolhope Club—Fishes in the Cornstone first discovered by Dr. Lloyd—Leominster recommended to the geologist as a locality for fossil fishes—Footmarks at Puddlestone—Fossil fishes of the Old Red sandstone—Puddlestone Church—Ludlow district

and Castle—Lowest Old Red beds near—The blind geologist—Upper Old Red conglomerate—The Clee Hills—Abergavenny—Valley of the Usk—Expedition with the Woolhope Club—Fish-scale found near the Daren by Sir R. Murchison—Upper Old Red organisms allied to Carboniferous—Expedition to the Black Mountains—Long Town and Llanthony Abbey—Hay district—Grand physical geology—Conclusion.

THE OLD RED SANDSTONE.

THE lowest part of the "Old Red" may be observed in contact with the Downton beds just described, or with the Upper Ludlow shales along the whole western range of the Malvern country; and the red marls, shales, and sandstones that cover up the Ludlow rocks cannot be mistaken by the most unpractised eye. At Hale's End, Mathon Lodge, at the bottom of Dog-Hill Lane, near Ledbury, at the back of Haffield Camp, the seat of Dr. Henry, and half-a-dozen other places, the Old Red deposits may be examined. But we will not loiter in this district; and we invite you to take a peep with us at old quarries, among old churches and old manor-houses, by running brooks in Herefordshire, where there are strange memorials of strange fish that lived and died in the seas of the Old Red, and which left bright hues among

grey sandstones, that have to us geologists a peculiar significance. We must take a passing glance, too, at the far-famed Black Mountains, that tower so boldly above all the Herefordshire hills, and rise in the neighbourhood of Brecon to the height of nearly 3000 feet. Before we start, however, let us ramble up the side of the Worcestershire Beacon, on a bright sunshiny day, when the air is clear; and seated on the summit, looking westward, far as the eye can reach, endeavour to take in the stupendous geologic history involved in that one view.

LOWEST OLD RED DEPOSITS.

One of the first lessons a geologist of this district learns, is, that the whole of the Old Red sandstone once lay above the Silurian rocks, and covered them up, as the present sea-beds cover up the masses that lie a hundred or a thousand feet below them. It requires no great effort of imagination, for the student looking westward from the Malverns to realise the period when the Silurian wooded hills and ranges were as yet not upheaved, the Cornstone ridges of Wall Hills, Mathon Wood, and the distant hills of Herefordshire not yet formed, or even

a particle of the mineral mass that enters into their composition detached from the parent rock. We would restore the scenery of the Lower Old Red sandstone. Far as the eye can roam the district before us is occupied by a rolling sea! The deposits are accumulated inch by inch, and foot by foot, over the once horizontal beds of Abberley, Ledbury, May Hill, Woolhope, Usk, Ludlow, Presteign, and other places, the whereabouts of which the eye may detect from the Malvern range!

Some strange change had taken place to alter the deposits in that ocean-bed; for the sediments are red, owing to the prevalence of the peroxide of iron, and before they were grey! The Silurian seas swarmed with life! The Lowest Old sandstone in Herefordshire is singularly destitute of organisms. Are we, then, to suppose that a lifeless sea during this period tossed its waves over the country we look upon?

Not so! There is a book, written by a man who once worked in a quarry, but whom God has endowed with great talents and great observation, to whose genius every scientific writer has borne witness, and of whom Dr. Buckland declared, "that he would give his left hand if

he possessed his powers of description." This book is *The Old Red Sandstone* of Mr. Hugh Miller, with which every lover of geology is well acquainted ; which tells us of the inhabitants of the sea, when deposits, identical with our Lowest Red beds of Herefordshire, were accumulating in spots as distant as the north of Scotland. In the south of England, too, synchronous strata were accumulated, which preserve their relics for our assistance in determining what animals inhabited the ancient waters of the period of the Lower Old Red.

We learn from the works of Hugh Miller, Agassiz, and others, that this lowest division of the Old Red contained no less than five species of that remarkable fish, found only in Old Red strata, and called *Pterichthys*, from its wing-like appendages. The *Dipterus* and *Diplopterus*, with their bony enamelled scales, were forms also peculiar to this lower division.

From strata that are synchronous with these in Devonshire, Sir R. Murchison, Professor Sedgewick, and Sir H. De la Beche, have described many shells of Silurian type, such as *Rhynchonella*, *Spirifer*, *Atrypa* ; but, with the exception perhaps of one (*Atrypa reticularis*),

all are of *different* species. The trilobites of the Silurian epoch are become extremely scarce, and strange fishes have usurped their places; the fossil fishes of the lowest Old Red are found in Russia with the shells of Devon, and this discovery settles at once the truth of the reasoning as regards these contemporaneous rocks. Among the sandstones of the lower group there occur, in Herefordshire, bands of carbonaceous matter, the product of animal or vegetable decay. As the lowest beds are, however, in this district peculiarly destitute of organic remains, we will proceed to the succeeding group of deposits, bearing especially in mind the distinct fossils and shells of our equivalent lowest Old Red deposits in Scotland, Devon, and Russia.

CORNSTONE, OR MIDDLE GROUP.

For unnumbered ages have the waves of the ocean rolled over the space before us; and *débris* and sand and pebbles have in the lapse of time filled up the recesses of the deep, and the sea-beds have accumulated many hundreds of feet in depth since the period of the lowest Old Red. The sea nurtures different fishes and different shells, and the fossil contents of the

rocks prove a change ; but a change no doubt gradual and slow, wrought during an immensity of time.

Mark well the hills of Herefordshire before us, when the Silurian upthrows are taken away. They are Cornstone groups, which were all once continuous ; and which, connecting by imaginary lines, we can make continuous now. Sink down in their former position beneath the Old Red deposits the Silurian rocks—join Wall Hills and Mathon Hill with those in the neighbourhood of Acton Beauchamp and Canon Frome—carry on the lines of junction to the • Tenbury and Bromyard district, and the rounded and conical hills so conspicuous from Malvern, called the Pyons, or Robin Hood's Butts, between Hereford and Leominster—take in the hills of Weobly, Moccas and Dinedor, all of which we see in the foreground,—and then endeavour to realise the time when all these distant hills were once joined by continuous deposits, and those deposits extended to the Malvern Hills. These strata, though now separated by many intervening miles, were once as continuous as the rind of an orange. The Cornstone marls and sandstones on the side of the

far-distant Blorengé joined those on the side of the Scyrrid, and those of the Breconshire Fans swept on to Foxley, Moccas, and the hills we have mentioned; and the sea was deep above them all towards the close of the Cornstone, or middle period of the Old Red sandstone.

The organisms of the Cornstone group are to be met with in Herefordshire; and compared with those of Scotland, as far as we at present know, they are identical. In Herefordshire we find the remains of species of the well-known *Cephalaspis* of Hugh Miller, a fish which he compares to "a saddler's cutting-knife." We recall his description of this formation:

"The curtain rises, and the scene is new. The myriads of the lower formation have disappeared, and we are surrounded on an upper platform by the existence of a later creation. There is sea all around, as before. Shoals of cephalaspides, with their broad arrow-like heads, and slender angular bodies, feathered with fins, sweep past like crowds of cross-bow bolts in an ancient battle. We see the distinct gleam of scales, but the forms are indistinct and dim; we can merely ascertain that the fins are elevated by spines of various shapes and patterns;

that some of the coats glitter with enamel, and that others—the sharks of this ancient period—bristle over with minute thorny points.”

As regards fossils, then, the Cornstone of Herefordshire is identical with the middle group in Scotland. There are no fossil shells in this deposit in Herefordshire, though they occasionally occur in Scotland; and the probability is, that in the Herefordshire strata the red oxides destroyed every vestige of their remains.

QUARTZOSE CONGLOMERATE OF THE UPPER
OLD RED.

Far above there existed, upon and above this Cornstone group, another member of the Old Red sandstone, distinct in time, distinct in its organisms, and the representative of a vastly later period of the planet's history. A careful investigation of the whole thickness of the Old Red sandstone, by Sir R. Murchison, gives its enormous depth at not less than from 8,000 to 10,000 feet; and we cannot avoid the conclusion, that enormous denudation and excavation have long since stripped off the upper group from *above the whole* of the Cornstone district. It is impossible to visit those distant

mountains, the Bloreng, the Sugar-Loaf, the Scyrrid, and the heights of the Black Mountains—the Fans of Brecon, without observing that the Upper beds which rest upon the Cornstone, though now widely separated, were once joined and continuous, and that they rose pile above pile high over the Cornstone hills of Herefordshire, even as they now rise on the summits of the Bloreng, the Scyrrid, and the Black Mountains. This upper member of the Old Red sandstone, or substratum of the Carboniferous limestone, is composed of pebbles of white quartz, in a red matrix, varying on the Bloreng from the size of a pea to that of an orange; we find it resting on the Cornstone group on the Fans of Brecon and Carmarthen, and may match it with the beds that girdle the coal basin of Dean Forest and Symonds' Yat, and again compare them with identical and contemporaneous deposits on the slopes of the distant Clee. The whole of the vast area around and above was filled up once by the Upper Old Red as certainly as its surface is now occupied by the lower deposits.

But we may not rest here; another history is connected with the country of the Old Red

sandstone, the very mention of which bewilders the mind, if unaccustomed to the wonders of geology.

It is impossible to doubt that the mass of the Carboniferous deposits once existed above the present site of Herefordshire and much of Shropshire.

There is a hill in the neighbourhood of Abergavenny, called Pen-cerrig-Calch, or the Hill of the Limestone Peak. Well may the geologist, when visiting that district, stop and contemplate that hill !

In ascending the Blorenges, we leave the Upper Old Red conglomerate, and find resting conformably upon it the lowest member of the Carboniferous series,—the Mountain limestone; above this again rests the Millstone grit, to which succeeds the coal-measure shales and sandstones. Pen-cerrig-Calch is a mass of Old Red sandstone, separated and detached from the Blorenges and Great Welsh coal-basin; but *on the top* is also a detached isolated mass of *mountain limestone* and *millstone grit*, corresponding, bed to bed and strata to strata, with the opposite deposits on the Blorenges; and not only with the deposits on the Blorenges and South

Welsh coal-basin, but with those on the far-distant Clee hills and the detached coal-basin of Dean Forest. Thus we have no doubt that the mountain-limestone masses which once connected the Blorenges and Pen-cerrig-Calch, also connected the Blorenges with the Clee hills and the Forest of Dean.

The Mountain limestone and Millstone grit of the Blorenges, and indeed of the whole of the great Welsh coal-basin, dip under deposits which in South Wales have been ascertained by actual measurement to attain the thickness of 12,000 feet; and who shall say that these coal-beds have not extended over Pen-cerrig-Calch, above the Scyrrid, above the whole of Herefordshire, and far on over the spot whereon we now stand, even the Malvern heights? The Forest of Dean is but a detached portion of the great Welsh coal-basin, preserved from denudation. The coal-beds of the Clee hills are but the shores of vast accumulations, which once extended far above those beds which now constitute the surface of the most of Herefordshire; and though the statement may seem more like the tale of a fairy land, yet we know that we speak truth when we assert that a vast area

above and around us, for thousands of feet together, now only occupied by the thin air or soaring lark, was, in former periods of this planet's existence, filled by a mass of sediment, the product of unnumbered ages, accumulated layer upon layer ; the upper surfaces of which were occupied by vast forests, drained by great rivers, and where the finest vegetation the sun ever shone upon flourished its allotted span, and when its hour was passed, was elaborated by the power of All-seeing Wisdom into Coal, that mineral which of all others most adds to the comfort, greatness, and happiness of man.*

This is no theory, but sober truth, taught to the geologist by evidence supplied by the "wondrous inscriptions chiselled deep upon the rocks." It is from such evidence he learns to argue, as he stands on an eminence like the highest pinnacle of the Malvern range, and grasps, in one extended survey, the astounding history of the past ; while, at the same time, he feels that in that one glance is comprehended a series of geologic histories which the studies of a life-time will fail thoroughly to appreciate.

* Delivered in an address upon the "Old Red Sandstone," before the Woolhope Nat. Hist. Field Club.

As a few hints upon the best line of route to my friends and brother-naturalists who may wish to work out these phenomena may be of service, I will endeavour to smooth the way, and save them many a weary mile, if they start expecting to "do the geology" of Herefordshire in a single tour.

I have always found my own legs the best and most independent way of proceeding on a geological journey; indeed, very frequently it is impossible to trust to any other mode of conveyance, and we can always obtain some means or other of getting over the ground we do not want to examine.

Having, therefore, made ourselves acquainted with the Lowest Old Red beds of the Malvern district, I should commence a pedestrian tour at Ledbury. The hill at the back of the town, crested with young fir-trees, is Dog Hill, an almost perpendicular upcast of Upper Ludlow rock, before alluded to. Let the time be eight o'clock on a summer's morning, and this the starting-point. Following the narrow lane that winds down the side of the hill towards the church, we come upon the Lowest Old Red beds, dipping under the Cornstone group of

Wall Hills, a considerable eminence two miles to the west, and resting against the Upper Ludlow rock. The positions, dip, and strike of these beds should be carefully observed. Many a geological blunder made at starting sticks to one for the remainder of the day. A pleasant half-hour may be spent at Ledbury. The ancient church, with its grey tower and handsome spire, and its old grave-stones, invite a visit from the passer-by. The situation is one of the most beautiful I know. There are no other attractions to tempt the traveller in the first town on the Old Red sandstone. Leaving Ledbury, and advancing westwards, Wall Hills rise abruptly on the left; and it may be as well at starting to make an acquaintance with this Cornstone Hill, as the lowest deposits have few charms and fewer fossils.

It is necessary to understand, that at each step towards the summit of this wooded hill we ascend in the scale of deposits as we ascend the steps of a ladder, and we walk over the *edges* of the deposits as if upon a succession of tilted tiles.

Sections here are difficult to find; but reckoning from the lowest beds we see at Dog Hill to the summit of Wall Hills, the geological sur-

veyors calculate that we pass over not less than 2500 feet of Old Red strata.

When at the summit of Wall Hills, we trace the remains of an ancient camp; and the Cornstones furnish the plates of *Cephalaspis Lloydii*, but so rarely that I do not advise a halt. It is worth while, however, to connect our imaginary lines with the hills of Canon Frome and the Cornstone hill of Mathon Wood, and reflect for a moment upon the denudation that has scooped out the intervening valleys: as we have to deal afterwards with denudation upon a much vaster scale, it is well to realise the lesser phenomena first.

After examining Wall Hills, I should recommend the tourist at once to throw his fossil-bag over his back, and lose no time in reaching (by the Hereford and Worcester mail) the Bartestree Dyke. The line of junction between the Old Red sandstone and the Silurians of the Woolhope range, on the west, may easily be detected by the colour of the soil, the red oxides of which extend but a short distance up the slopes of the hills. I do not know an instance of a quarry in the Old Red sandstone worth visiting in this district until we reach

the trap-dyke at Bartestree, between Dormington and Lugwardine. This trap constitutes a remarkable dyke, described by Sir Roderick Murchison (*Silurian System*, 186) as "a highly crystalline greenstone, made up of hornblende, olivine, and felspar." It is not the least like the syenite of the Malvern Hills, but more resembles the prismatic greenstone on the left of the Holly-bush Road, near the lodge at Bronsill Castle. The rocks through which this ancient lava passes are sandstones, I believe, belonging to the lowest division of the Old Red beds; and if of the Cornstone series at all, must lie at the very bottom of the group. This quarry has altogether a striking aspect, and a very volcanic appearance; the trap itself once stood out in a hard ridge, which has been quarried for roadstone, and the sides are now railed round to prevent accidents; many wild flowers adorn the bank, and it is a favourite spot for the Comma butterfly. These altered sandstones and marls, which have actually been baked under pressure, afford the best example we know in Herefordshire of volcanic phenomena connected with the Old Red sandstone strata. A few fields to the west of this dyke, we find the

protruded Silurian dome of Hagley Park; and when the elevation of these beds is compared with the great upcast of the Woolhope area on one side, and that of Shucknall Hill upon the other, we cannot avoid the conclusion that such dislocation would on all sides produce crevices and cracks in the superincumbent strata. In this region, Plutonic forces have in many places thrust the Silurian beds through the overlying Old Red sandstone; and the Bartestree Dyke is one of these crevices filled with an ancient lava, which has thus been enabled to force its way to the surface from the depths below.

Strange that this hard and valuable roadstone is not more quarried for road purposes, as one ton is worth two of the softer Shucknall-Hill rock, so much used in this neighbourhood. The workmen need not fear the supply failing, if they will quarry *deep enough*!

There is a startling abruptness in this trap-dyke of Bartestree, when we come upon it unexpectedly in the midst of a green meadow, and surrounded by old trees. I have often stood idly at the top, thinking of the history of its upheaval; and recollections arise whenever

I now visit it of pleasant rambles with dear friends, with whom I first learned to appreciate the beauties of Nature, and who are, alas! now in the grave. The little church at Bartestree is the smallest house of God I ever visited; it has been lately restored, and is a quaint little church, by a quaint old lane, where tall hedges, rustic cottages, and clustering trees make up a pretty Herefordshire scene, especially when the hops are ripe and the apples rosy.

The Hagley Dome will of course call for the next visit from the geologist, the peculiarities of which have been elsewhere described. As the beautiful scenery of Herefordshire is a never-failing spring of delight, no one will fail to observe the view of old Hereford, and the distant hills in the background, while descending the hill towards the picturesque village of Lugwardine. Let no one think of keeping the *turnpike-road* between Bartestree and Hagley, or he will lose one of the most pleasant rambles in this part of the county.

At Lugwardine there is an extensive quarry close to the road-side, and in which I have succeeded in obtaining the triturated remains of fishes, and some fair specimens of sea-weeds.

These sandstone strata belong to the bottom of the Cornstone group, or rather to the top of that part of the system, No. 15, of Professor Phillips, in his work on the Malvern and Abberly Hills (p. 102). In the immense blocks from the Lugwardine quarries, very few fossils have been discovered, save those alluded to above; but the very few Herefordshire geologists live at long distances from this part of the county. Railroads have only of late been opened; and in the course of a few years, in all probability, notes on natural history will be more extended in this county than at present.

The country-people of Herefordshire are not, as some have supposed, lower in the scale of intelligence than their brethren in many other counties of England, and we only wish they enjoyed more opportunity of improving their minds and social positions. Many of the agricultural inhabitants possess a very fair share of local information. Herefordshire boasts several good and some distinguished botanists, amongst whom we need only mention the names of Bentham and of Purchas. Hereford itself possesses a natural-history museum, which contains specimens of Chinese slippers, butterflies,

and umbrellas, but few local fossils or birds, and *no* plants illustrative of the natural history of the county. The minerals, however, presented by Mr. Arkwright are worth notice. At Hereford we should advise our friends, on a geological foray, to take up their quarters for the night; as a city it has often been described, and we only beg of the stranger not to fail to visit, first the cathedral, and secondly, the Castle Green. As for inspecting the Museum, we shall say, as Punch does of committing matrimony,—“*Don't.*”

From Hereford, as a central locale, the Cornstone, or middle masses of the Old Red system, may every where be visited with ease; and a fair collection of its fossils accumulated from the districts of Weobly, Leominster, Bromyard, and Monmouth Cap.*

Until the establishment of the Woolhope Club, a dozen specimens of the remains of the fishes of the Old Red were all the fossil relics known in the county of that deposit of which Sir Roderick Murchison declares, of its deve-

* While this work was in the press several remains of *Cephalaspis* were found by the Rev. W. Thackwell near Monmouth Cap.

lopment in and around Herefordshire, "there is no such other tract in the world."

That the Cornstone group was known by Sir Roderick Murchison, the late Dr. Lloyd of Ludlow, and the Rev. T. T. Lewis, to be fossiliferous in the Leominster, Tenbury, and Bromyard districts, is a matter of history; and that fishes existed in strata of this age was declared by Dr. Lloyd of Ludlow as early as 1827.. No naturalist, however, has until lately taken the trouble of collecting specimens, since the publication of the Silurian system; and few persons in the county have the slightest idea what the Old Red ichthyolites are like. The investigations of the Nat. Hist. Society,* alluded to above, have tended to revive an interest in the geology of the county, and the name of Hugh Miller is becoming known in Herefordshire. The description of the organic remains of the Old Red sandstone given in the *Silurian System* (p. 588) has been, we have reason to believe, referred to; and it is possible that Nature's works, so remarkable in this county, may be henceforward not altogether neglected!

To our geological friends we can give no

* Woolhope Club.

better directions than to proceed from Hereford to Leominster by rail, and to take the line of quarries from Kimbolton Church by Lyster Sprowle, returning by Puddlestone and Birch. Heads, tails, and plates of four different species of *Cephalaspis* abound in these quarries, and the blueish and plum colours they affect at once strike the eye of the collector. The present president of the Woolhope Club, the Rev. T. F. Crouch, possesses an interesting collection of fossil remains, all of them from the quarries of this district.

The large quarry at Puddlestone affords instances of ripple-marks that were produced by the waves of an Old Red sandstone sea, and a small crustacean has left its footmarks on those ancient shores. I was extremely anxious to obtain a slab with footprints from this quarry, for the examination of the celebrated ichnologist and naturalist Sir W. Jardine; and for a most instructive specimen I have to thank the courtesy of Mr. Miller, who resides in the neighbourhood.

The strange remains of the fishes of the Old Red sandstone must always fill the young geologist with wonder; and if he is ignorant of

ichthyology, he requires to be told that these ancient denizens of the ocean were covered with bony plates or scales of a kind of enamel, and that they belonged to the *Ganoid* order of fishes, so named from *ganos*, splendour; and splendid, indeed, is the shining enamel of their scales! In the Old Red sandstone epoch all the known fishes were *Ganoids*; now the *Polypterus* of the Nile and bony pike of America are the only representatives of this once numerous race. The celebrated ichthyologist, M. Agassiz, divides the order of fishes into four great groups, which are distinguished by the structure of their scales. First we have the *Ganoid*, with its enamelled scales; secondly, the *Placoid* fishes (*plax*, a plate), with their bodies covered irregularly with plates, sometimes fining down like the shagreen of the shark; thirdly, the *Ctenoid* (*kteis*, a comb), with comb-like or jagged scales, as the perch; fourth, the *Oycloid* (*cyolos*, a circle), with bony smooth scales with no enamel, such as the salmon.

The tail also of fishes furnishes a marked distinction. The shark and the sturgeon have their tails unequally lobed, or heterocercal (*heteros*, different, and *cercos*, a tail), and the back-

bone is prolonged into the upper lobe. All the fossil fishes of the Old Red sandstone were heterocercal; and fishes with equally-lobed tails, or homocercal (*homos*, alike), did not make their appearance upon the planet's surface until ages after the Old Red sandstone and the inhabitants of its seas had been covered up by other strata. A vast deal is to be learnt upon the anatomy of fishes, before the geologist can comprehend the strange forms of this period. Upwards of sixty-five genera and species have been described from the Old Red sandstone of Scotland; and the celebrated English ichthyologist, Sir P. de Grey Egerton, has recognised three species of *Cephalaspis* from the quarries of Lever Hill and Lyster Sprowle. It was the fashion of geologists to say that the Old Red sandstone of Herefordshire contained very few fossils. I beg to assure my friends, that the district I now recommend is, on the contrary, particularly rich!

The vagrant geologist, with his "traps" upon his back, is independent of turnpike-roads and stage-coaches; and I certainly do not recommend a return to Leominster when Ludlow is within his reach, unless he be a botanist, and

wishes to investigate the tribe of grasses that grow in the streets. I must, however, mention, that a most interesting collection of domesticated ferns has been made by a gentleman in that town.

I had nearly forgotten the little parish-church of Puddleston, which, on visiting the quarry of the ripple-marks, is about a mile to the north, and should not be passed by. The arrangement of the interior is admirable, with the exception of the stained-glass windows, and does great credit to the architect and its restorer, the squire of the parish (E. Chadwick, Esq.) *Apropos* of the windows, they may be considered ornamental; but to my taste such copies from the square arms and legs of the old masters are great mistakes, and tend to excite one's risibility, rather than devotional feelings, on visiting this otherwise beautiful House of God. The churchyard is what a Christian burial-ground should be, not a plot of ground overgrown with nettles and long grass, but a decent resting-place for the Christian dead,—one that indicates repose, and not desecration, sacrilege, and neglect. Puddleston church and churchyard are well worthy of observation!

Let Ludlow, by all means, be the next scene of the geologist's exploration, and "don't" neglect the museum.

And what a scene is the Ludlow district, whether we consider its geological history, or the bygone centuries of human grandeur and decay that Ludlow Castle tells of! The very stones of which the castle is built contain the fossils of an epoch long passed away, and remind us at the same moment of the armed knight and his stout sword, and the sweet song of England's noblest poet (Milton). The grass grows in the banqueting-hall; yet the body of the trilobite still preserves its shape in its old stones, and the same bright sun of Silurian times still shines above the enduring works of nature and the mouldering works of man. The tenant of those Silurian seas, that once rolled and dashed above the Castle Hill, remains far more unchanged than the bodies of heroes, who, with lance and sword and iron shroud, lie in their now-forgotten graves.

It was in the neighbourhood of Ludlow, and in the hills between Tenbury and Leominster, at some of the quarries to which we have alluded, that the late Dr. Lloyd discovered

the first fish-remains from the Cornstone group; and the specimen figured in the *Silurian System* (pl. 2, fig. 1) is in the Ludlow museum. This interesting collection comprises a good series of Silurian local fossils; and we only regret that the fossil fishes of the Old Red sandstone should have received so little attention. We have Sir R. Murchison's authority for declaring that "there is no district in which the nature and relations of the Cornstone can be better studied than to the north of Ludlow, where the formation occupies a distinct range of hills rising to the height of four or five hundred feet above the low country, and presenting escarpments to the valley of Corvedale" (*Silurian System*, p. 179). When last I visited Ludlow some remains of fossil fish were shown me, collected by my friend Mr. Humphrey Salwey, and Mr. Lightbody, from the railroad-cutting near the town. One of these fragments, a portion of an ichthyodorulite, was unknown to Sir P. Egerton; and I would particularly call the attention of the geologist to these beds, which unfortunately I had not time to visit. From their described position, as regards the Ludlow rocks, I suspect them to be the *Lowest* Old Red deposits, below

the Cornstones; and if so, the most fragmentary remains of their fossil fishes may be of considerable importance in determining their age, as the only Lower Old Red fish I have ever heard of from the Herefordshire district is the *Dipterus* detected by Sir R. Murchison near Ludlow, in the very bottom of this system (*Silurian System*, p. 588), and the fragments collected by Mr. Strickland and myself at Lugwardine.

It is unnecessary to call the attention of the geologist to the Upper Silurians of the Ludlow district, and the Ludlow "bone-bed," but we may mention, that the well-known trilobite *Calymene Blumenbachii* is found in great numbers at Burrington Cliff, near Leintwardine. Indeed, Silurian fossils are every where abundant, and I have never failed to fill a heavy bag. One of the most remarkable expeditions I ever took was over the hills and quarries around Ludlow, in company with a *blind geologist*, led by the hand of a fair and faithful friend. I never met any one who entered more thoroughly into the subject. There was a solemnity in his manner, when he spoke upon some subject connected with primeval ages, that was very impressive. Not a fossil was found that he did not recognise

by *touch*. The sun shone pleasantly; and although the blind geologist could not see the lights and shades upon the distant hills, so much enjoyed by those around him, there was a light within that no loss of outward vision could quench, and which continually shone forth in perceptions of deep feeling and truth.

We might linger long at Ludlow; but we must pocket our hammers and fossils, and jog on to examine the Upper Series of the Old Red sandstone.

OLD RED CONGLOMERATE (UPPER BEDS).

The geologist should by all means trace the Old Red sandstone from the valley of Corvedale up the steep acclivities of the Clee Hills, where the Upper beds may be seen conformable to the Lowest sandstone of the coal measures. The position of this upper conglomerate should especially be marked, for comparison with corresponding beds at points as distant as the coal-beds of South Wales, the Forest of Dean, the upper beds of the Scyrrid, Bloreng, Pen-cerrig-Calch, and the Black Mountains.

The Clee is grand working-ground for the

geologist, with its ancient lava or Plutonic rock, penetrating the Carboniferous deposits, and altering the coal itself. The ancient basalt is locally named "Jewstone;" and it is probable that the subterranean forces which elevated this portion of a coal-field that once lay above the whole of Herefordshire, were the means of preserving those strata from the denudation to which the more central deposits were exposed. It is, however, to the Old Red sandstone conglomerate on the flanks of these hills that for our present purpose we draw the attention of the tourist, and request him to bear in mind, that the same beds occupy the summits of the Fans of Brecon and Carmarthen, and the gorges of the Black Forest; and when he has examined the district of the Clee Hills, our advice is, to take the rail at Ludlow, and journey on to Abergavenny. When President of the Woolhope Field Club, I had the pleasure of examining the contemporary and equivalent beds of those on the sides of the Clee, and the flanks of the Blor-enge, in the company of several of the members. The pleasant town of Abergavenny is surrounded with picturesque hills, all of which exhibit the immense development of the Old

Red sandstone; and from this place we commenced our examination.

The valley of the Usk is a great line of fault or dislocation, caused no doubt by that earthquake action that succeeded the coal period, when the Palæozoic deposits were broken up and laid on edge,—when volcanic eruptions poured forth from vast depths the “Jewstone” of the Clee,—when consolidated mineral masses, such as the Malvern syenite, were thrust bodily through enormous sedimentary deposits that lay above them,—when, in short, the long Palæozoic epoch ceased to be, and another creation, at the Creator’s fiat, came forth, and new forms succeeded old types. Along the sides of the valley we saw immense mounds of boulders and gravel, the detritus of materials that once occupied a surface far above our heads. The rough sand and rolled pebbles were all that remained of the immense masses which once connected the Blorenges with the Scyrrid, Sugar-loaf, and Pencerrig-Calch. We gazed in wonder at the mountains around us, not only as evidences of the enormously long period during which those boulders and pebbles were gathered together in bygone ocean-beds, but still more as proofs

of the furrowing-out of the strata, which at one period filled up the very valley we were walking up, to the depth of upwards of 2000 feet, and united the widely separated mountain-masses around us. Much did we speculate on the former history of the white quartz pebbles and the red matrix of former mud that compose the Upper "Old Red conglomerate." At what depths of the ancient planet were those quartz pebbles formed; and when upheaved, what ancient land or sea-girt rock did they compose, before they were detached, washed by the waves, and rolled into their now "bullet-like forms," at last to be deposited in beds of soft red mud, now nearly as hardened as themselves?

We know that strange forms of fishes inhabited the seas whose waves thus rounded the white quartz pebbles; but what of the shores? What animals then lived? What trees or plants grew upon the land of that far-off period? Such were the questions we country naturalists asked ourselves, on our expedition to visit more particularly the uppermost beds of the Old Red sandstone. Our friends who may be induced to follow in our footsteps will doubtless reflect also upon such-like subjects; and believe me,

on the honour of a brother geologist, no one who visits the neighbourhood of Abergavenny, and its piled monuments of the wondrous past, will forget the marvels there related by the stones of the Old Red sandstone. For my own part, I never see the upper beds of which we are speaking without recalling the eloquent description of the first of Scotch geologists (Hugh Miller) on the opening scene in the history of the Old Red period :

“ The first scene in the *Tempest* opens amid the confusion and turmoil of the hurricane, amid thunders and lightnings, the roar of the wind, the shouts of the seamen, the rattling of cordage, and the wild dash of the billows. The history of the period represented by the Old Red sandstone seems, in what now forms the northern half of Scotland, to have opened in a similar manner. . . . A vast stratum of water-rolled pebbles, varying in depth from a hundred feet to a hundred yards, remains in a thousand different localities, to testify of the disturbing agencies of this time of commotion. The hardest masses which the stratum encloses,—porphyries of vitreous fracture that cut glass as readily as flint, and masses of quartz that strike fire quite as pro-

fusely as steel,—are yet polished and ground down into bullet-like forms, not an angular fragment appearing in some parts of the mass for yards together. The *débris* of our harder rocks, rolled for centuries in the beds of our more impetuous rivers, or tossed for ages along our more exposed and precipitous sea-shores, could not present less equivocally the marks of violent and prolonged attrition than the pebbles of this bed.” There is scarcely a word of this description of the lower beds in Scotland, which may not be applied to the *closing* scene and upper beds of the Old Red sandstone of Herefordshire, Monmouthshire, and Brecon. The conglomerate with its rolled pebbles, at the base of the Carboniferous series, contains the remains of fishes identical with the contemporary beds of Scotland. At the Daren, near Crickhowel, Sir Roderick Murchison found the impression of a large scale of the *Holoptychius*, a fish in Scotland especially characteristic of the upper formation. I am not aware that other specimens have been detected in these beds in the district before us; and for one very good reason,—nobody ever looks for them!

The *Holoptychius* was a massive ganoid,

cased in enamelled armour ; and six species are now enumerated from the upper beds of Scotland. A species of *Pterichthys*, different to the *Pterichthys* of the *lower* beds, occurs in Scotland with the *Holoptychius*.

Holoptychius, however, is the characteristic fish of the upper division of the Scottish Old Red ; and, as we have seen, it occurs in the Upper Old Red conglomerate of the hills near Abergavenny. The oldest known reptile (*Te-lerpeton Elginense*) was found by Mr. Duff, of Elgin, in sandstones which are contemporary with our Old Red conglomerate ; and land-plants, with fresh-water shells, occur in similar strata in Ireland.

It should be especially remarked here also, that while land-plants in the *lower* beds of the Old Red are extremely rare, tree-ferns and calamites are found in the *upper* group of deposits ; and that, in Russia, the sea-shells of Devon and the strange fishes and plants of Scotland lie in the same grave. On referring to the shells of the upper beds of Devon, we find their forms drifting, as it were, towards the shapes of the Carboniferous limestone, while in the lower beds they still affect the Silurian

type. All these evidences the geologist will consider when he visits the Old Red conglomerate; and he will then remember that there *are* answers to his questions: What of the land? What of the animals? What of the fish? What of the sea-shore?

Were I to recommend my friends to visit all the localities of the Old Red sandstone I think worthy of attention, these pages would assume a much more formidable shape than I ever intended. For instance, Ross, Dean Forest, and much of Monmouthshire, should not be passed by: the gorges of the Wye, too, are most instructive; but these are familiar scenes,—and I would mention one more ramble less known and frequented.

About eighteen miles from Hereford, and five from Abergavenny, is the little country-station of Pandy, on the Newport and Hereford line; and it was from this starting-point, at least as regards the pedestrianism, that I had the pleasure of conducting a party of *savans** last summer through some of the wildest scenery of the Old Red sandstone.

This station is within a mile of the base of

* The Worcester botanists, Messrs. Lees and Baxter.

the Black Mountains, where they slope off in the direction of Abergavenny. Crossing the Hondu, we pass by an old manor-house, and ascend the hill, at the base of which the strata are seen cropping out, and may easily be studied. A walk of three miles brings the tourist to the summit of the hill, deep valleys running on either side. But how different is the scene on the northern from that on the southern aspect! On the right, the corn-fields of Herefordshire are spread far and wide, and the eye rests on distant villages and towns,—all the scenery on this side bears the impress of the haunts of man; while, on the other, a truly wild Welsh country, with heather-covered mountains, and distant sheep cropping the short turf, and mountain-streams, forming a perfect contrast. On one side is the old church and castle of Longtown; on the other, the grey decaying turrets of Llanthony Abbey. I cannot venture to draw the picture of that view, where we have at once the stern outline of hill-scenery and the softness of the cultivated vale. I remember well taking a friend from the Herefordshire side up the steepest part of the hill without giving him an idea of what the opposite

scene would be: we stood immediately above the old abbey of Llanthony; and after a few moments' silence, he said, "Wait one moment, while I take my hat off, and thank God that I have seen this view." We follow a footpath for about a mile down the hill-slope to the ancient abbey. I suppose there are few so dead to Nature's feelings as to look around those ruins, and listen to the traditions connected with the abbey, without interest. But we have other points of the Old Red sandstone to visit, and we must hurry onward; not, though, without a dish of fresh trout from the mountain-stream that runs close by, and a chat with the pleasant hostess who lives in the still habitable portion of the "auld abbey." There are many legends to gossip over, and haunted rooms to visit; but such tales come not within the province of the geologist!

Ascending the valley in the direction of Hay, the scenery becomes still more wild and solitary, and it is hardly possible to believe that we are so near the cultivated and civilised world. A Welsh-looking farm-house, with its everlasting whitewash, and a tumble-down mill, are the last vestiges of habitations, until at last

we find ourselves on a complete moorland, and the bare hills of the Black Mountains. All the way up this valley is good ground for the geologist; for, by tracing the beds in gulleys and hill-side openings, he begins to comprehend the vastness of the accumulations of the Old Red sandstone period. Every step we advance upward, we find new beds; and though bewildering at first, the problem is solved at last. The ridge of the Black Mountains, above the Hay district, stands out in a dark abrupt outline; and below again appears cultivation and human abodes.

This part of the country contains the grandest physical geology I am acquainted with, and affords attractions not to be met with elsewhere, at least in this neighbourhood; and yet is this little excursion almost untrodden ground by the geologist and naturalist. We travel to Norway, the Rhine, Scotland, Ireland, America; but, with the exception of Sir R. Murchison and the geological surveyors, I never could hear of any one, in Herefordshire at least, who knew the scenery of the Black Mountains: I suppose because near home!

I think few geologists who have visited this

scene will be disposed to deny that it leaves on the memory a feeling of the sublime which is to be felt and not described. The pebble of the brook, the quarry in the glen, the vale, the hill, the crag, each white quartz pebble, or pile of rock, or common piece of sandstone, converse, as it were, in language of their own, and every mile awakens some new impression and vivid idea.

When working out the geology of this district, no one should be without a copy of the section given by Sir R. Murchison (*Siluria*, page 243), across the whole area of the Old Red sandstone, from the bottom beds of the South Welsh coal-field on the south-east, to the Upper Ludlow rock and Tilestones of the Treverne Hills, on the north-west. It is over this country that the geologist gazes when on the ridge of the Black Mountains facing the north-west. The distant hills are Silurian masses; all of which gradually dip underneath the Old Red sandstone group upon which we stand. With Sir Roderick's section in our map-case, the phenomena are easily understood; and at this point we take our leave of our geological friends, and recommend the little town of Hay for their

resting-quarters. From this place there are two coaches daily towards Hereford and the land of railroads: and I do not think, as they wend their way towards the town along the picturesque outlines of the Black Mountains, or ramble down their slopes towards the valley of the Wye, they will regret that day's walk over the district of the Old Red sandstone.

One word in parting. We are not an educated people; and I have no hesitation in agreeing with Mr. Cobden, "that the mass of the English people are the least instructed of any Protestant community in the world." They say the spirit of the age is in favour of scientific acquirements; and the educated, at least, among the people of England, begin to appreciate those studies which lead to the perusal of Nature's history, and the investigation of their Creator's works. God grant it is so! Science and natural history, geology and botany, are high-sounding names, but, after all, much of their teaching relates to the common things of common life; and I do not see why the blessing, if I may so express it, which attends their acquisition, may not be held out, in simple teaching, to the poor man as well as to the rich. The earliest efforts

of the infant mind are directed *naturally* towards the observation of *natural* objects. Our present system of education is utterly to ignore the observing powers, and disgust the mind, by cramming our school-children with religious doctrines, difficult of comprehension even to the learned, and utterly unfathomable to the young.

How often have I ardently hoped that I might yet see the time when the education of the English people may begin at the *right end*. When the legislator and clergyman and school-master will realise the fact, that God Almighty's works are worth knowing and inculcating; and that, however important the blessings of a knowledge of His divine Word, there is no reason His Works should be neglected or despised! I know, from my own experience, that the cultivation of such knowledge does elevate men, no matter how lowly their occupation or laborious their employment. There is a history attached to every natural object; but of which, unfortunately, too many persons in this country are as ignorant as the stones beneath their feet. I believe our working-men would be wiser, happier, nobler beings, if in their early youth

they were taught the elements of these things; and I do *not* believe that it is quite sufficient for the poor man to know that stones are stones, and stars are stars, and flowers are flowers, when every country village has its botany and geology and astronomy, wherein the Works of the Creator are manifestly set forth. Good *old* times! Oh, for the good *new* ones, when the gentle voices of the daughters of the land shall be heard in our village schools, and amongst our village people; and lending-libraries shall be established, and books carefully selected, which shall unite the instruction of His revealed *Word* with His revealed *Works*, and the youngest child shall be taught principles and ideas which our old men have never dreamed of;—when the *educated* youth shall leave his college knowing more of comparative anatomy than the points of a horse; of chemistry than the combination of sloe-juice and port wine; and even of geology, the history of the stones of the field, than that they are “hard and simple things,” useful only to mend roads and make mantel-pieces!

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